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NOTES ON THE UTILIZATION OF FORESTS.

(*Continued from page 418, Vol. XVI.*)

CHAPTER III.—UTILIZATION OF THE BARK OF TREES AND SHRUBS.

THE principal uses of bark are for tanning and dyeing, and for furnishing fibres and drugs. On a small scale, it is also employed as covering material, as fuel, and for some minor industrial purposes.

SECTION I.—BARK FOR TANNING.

Tannin is the generic name given to a large class of organic bodies, mostly uncrystallizable, which often differ widely in chemical composition and reaction, but have the common property of precipitating gelatine from its solution and forming insoluble compounds with gelatine-yielding tissues.* By virtue of this property they convert animal hide, which is easily putrescible, into insoluble imputrescible leather. They all form blackish-blue or blackish-green compounds with ferric salts, and when treated with alkalies, they give solutions which oxidize rapidly, usually becoming successively orange, brown, and black. Associated with catechu-tannic acid a white crystalline body is found, called catechin, which does not precipitate gelatine. The tannins are met with chiefly in parenchymatous tissues, especially in bark and young wood, in the pericarp or other coverings of green fruits, and in the excrescences called galls. Leaves that darken in drying, like those of the tea plant, of *Anogeissus latifolia*, &c., are rich in tannin.

From the tanner's point of view, tannins may be divided into

two principal classes, *viz.*, those which produce a light fawn-coloured deposit (the bloom) on leather and those which do not. To the first of these belong the tannin of myrabolams, to the second the tannin of cutch.

Tannin is a substance so easily soluble in water that bark intended for it has to be taken off with the greatest care. Bark may be removed (1) from a standing tree, or (2) from fresh-felled wood, or (3) from wood that has become more or less dry. In the first two cases it should be possible to strip the bark off the wood without difficulty; hence the barking must be effected when the union between the bark and wood is weakest, that is to say, at the beginning of the season of vegetation, from the moment the buds begin to swell up to the time the leaves attain their full size. During this period, the cambium is exceptionally active, and the tissues on either side of it are soft and gorged with sap, so that the bark can then be separated from the wood easily. Moreover, owing to this special activity, the liber also contains at this time its maximum amount of tannin.

The only portion of the bark which contains tannin in useful quantities comprises the living layers; the dead bark is practically of no value at all. Also, owing to the great solubility of tannin, the moment the periderm begins to split and a rhytidome to form, rain and dew both reach the living layers through the cracks and wash out a large proportion of the tannin. Hence the best stems for the tanner's purpose are those of vigorous growth which have still a smooth uniform shining bark. When this period of growth is past, the yield of tannin diminishes considerably. According to Mueller, as quoted by Gayer, the bark of young poles contains twice as much again of tannic acid as the bark of full-grown trees. The best stems are unquestionably young coppice poles, and coppice worked for tanning bark should be exploited on short rotations. The great drawback in the case of bark which contains a considerable proportion of dead rhytidome is that this latter *must* be got rid of, always with immense trouble, before the bark can be used. The rhytidome without appreciably increasing the amount of tannic acid, introduces a large quantity of undesirable colouring matters into the tanning liquor.

The removal of bark from standing stems (technically termed *peeling*) is thus effected. With a sharp broad-bladed hatchet or a curved bill the bark is cut through round the base as far as the wood. A similar cut is made 3 or 4 feet higher up. Then with the tool represented in *Fig.* 62, which is very sharp along the edge *e*, a straight incision is made from the top cut to the bottom.

The bark on each side of the incision may now be lifted up with ease with the extremity of the same tool or with the ordinary *khurpa* of the Indian gardener. After this, the workman has only to gradually strip off the entire cylinder of bark, aiding himself with the tool wherever it adheres too firmly to the wood. In this manner he peels off successive complete rolls of bark until the entire stem and the thicker branches, if any, have been laid bare. This method of barking is evidently unsuited for large trees. Moreover, it is the most troublesome of the three methods, and should, therefore, be employed only when the stems to be peeled cannot, for some reason or other, be felled at once.

Fig. 62.

Bark scalpel.

In the second method, the bark is stripped off immediately the trees have been felled. The tree may of course be of any size. If the stems are small enough to be rolled about, they may be peeled in the same way as standing poles, the bark being taken off in complete rolls. In the case of larger stems, the bark must necessarily be pulled off in narrow strips like semi-cylindrical tiles ; the bark being thick, with a hard rhytidome, all the incisions must be made with an axe, and in order to loosen it, it has often to be beaten with the back of the axe.

In the third method of barking, the tree is cut up into billets, and at any timea fter the tree has been felled, the billets are exposed to the action of steam, under which the bark swells up and is easily detached. It is evident that only comparatively thin wood can be peeled in this manner. Ordinary steam, owing to the solubility of the tannin, injures the quality of the bark, and hence the best apparatus are those in which superheated steam is used. Portable apparatus, weighing less than 600 lbs., have been constructed, which, with the labour of only four individuals, give an outturn of more than 2,000 lbs. of bark a day. The researches of Grandeau have proved that the steaming does not affect at all the yield of tannic acid.

Under ordinary circumstances the bark itself is exported after being dried, in order to reduce its weight and volume and to prevent fermentation. Air-dried bark is only from one-half to two-thirds the weight of the green bark. The diminution of volume resulting from air-drying varies from 20 to 40 per cent. To dry the bark, the rolls are stood up close together against one another in the form of a pent roof, a line of rolls being placed along the top like ridge tiles ; or they are piled up in a single row, in low stacks, on

trestles raised at least a foot from the ground. In fine weather they become sufficiently dry in two or three days. Heavy rain is fatal to the bark, and hence, unless the steaming process is resorted to, drying in the open is out of the question for most of our Indian species, since their growing season is ushered in with continuous wet stormy weather.

To obviate this very serious drawback, it is matter for consideration whether it would not be best to fix the season for felling without reference to the production of tannin, and to extract the tannin at once, thus exporting the extract instead of the very much more voluminous and heavier bark. The extract could be either dry and solid or a thick liquid. In either form the tannic acid would keep for ever, whereas in the bark it disappears in the course of two years in spite of the utmost precautions, and combined great heat and humidity, such as obtain in the hold of a ship, would cause it to decompose in a much shorter time. This plan would save cost of packing and carriage in a very remarkable degree, so that our forests, in which thousands of tons of bark now go annually to waste, could supply not only local tanners, but tanners in the most distant countries.* To Captain Wood is due the credit of attempting to introduce this practice into India and thereby utilizing the vast resources of our forests in tanning bark. He has experimented with sál and *Terminalia tomentosa*. The bark

* The practice of preparing a tanning extract by boiling chips of wood of the sweet chestnut is a very old one, and for many years now the system has been very successfully applied to oak wood in Europe. Within the last 30 years an extract of the hemlock (*Abies canadensis*) bark has taken the place of the crude bark in the exports from Canada and the United States. The mode of preparation is an instructive one for us in India, who have to devise some way of turning to profitable account the thousands of tons of bark which go to waste every year. The bark, in pieces ½ to 1 inch thick and several inches long, is soaked for about 15 minutes in water at 200° Fah. It is then fed into a hopper, which conducts it to a 3-roller machine, something like a sugarcane mill, through which it passes, coming out lacerated and compressed. It next falls into a vat of hot water, where it is agitated by a wheel in order that the tannin from the crushed cells may be dissolved in the water. Hence it is raised by a series of buckets, on an endless chain, to another hopper, whence it is fed to another 3-roller mill. Here it receives its final compression, and comes out in flakes or sheets, like coarse paper, and almost free from tannin. The buckets are made of coarse wire, that the water may drip through. To avoid the blackening action of iron, wherever this metal is brought into contact with the solutions, it is thickly coated with zinc. The solution is evaporated to a solid consistency, generally in vacuum pans. About 2 tons of bark yield 500 lbs. of extract, containing 18 to 25 per cent. of a deep-red tannin, giving considerable weight and firmness to leather.

is chopped up in pieces about 4 inches square and boiled in earthen pots, the strained liquor being completely desiccated or reduced to the consistency of treacle. The extract prepared by the Oudh Forest Department has the defect of containing too much dark colouring matter; but this is, no doubt, due in a great measure to portions of the dead bark having been boiled with the lighter-coloured living bark, a practice to which must also be attributed the very poor outturn in tannic acid (only 2½ per cent. of the dry weight of the bark). With a proper system of manufacture, the yield would be at least doubled, and the percentage of tannic acid in the desiccated extract would certainly reach 50, instead of only 33 as at present. The price of chestnut wood extract, containing 30 per cent. of tannic acid, varies in London from £12 to £15 a ton. There is no reason to suppose that a great many of our gregarious trees would yield a worse commercial article than this latter extract, and we thus only require capital and enterprise to enable our tanning materials to compete successfully in all the markets of Western and Central Europe with such materials from other sources of supply. If caste prejudices militate against the expansion of the tanning industry in India and the local conversion into leather of the shiploads of raw hides which leave the country every year, they cannot be a bar to the preparation of tanning extracts.

We have as yet no figures for the proportion of tannic acid contained in the barks of our various species. Even in Europe the figures are few and contradictory for the three or four species used. In France a quantity of acid varying from 5 to 7 per cent. of the dry weight of the bark is considered good. In Germany the best bark is said to yield 16 to 20 per cent. of its dry weight of tannic acid. But the practical tanner does not value bark only by the quantity of tannic acid present in it. Even in one and the same tree the bark is prized more highly by him, the lower it is obtained from the tree, although the bark from the upper portion of the stem is, as a rule, very much richer in tannin than that from the base. The commercial and practical value of a tanning material depends not only on the quantity of tannin present in it, but also on the character of the leather it produces, whether hard or soft, dark or light-coloured, and heavy or light.

The volume of the bark varies from one-third to one-eighth that of the original unbarked wood, according to the age of the portion or the tree from which this latter has been taken. Hence the barking of firewood diminishes very appreciably both its weight

and volume. On the other hand, the peeled wood always commands a relatively higher price, while the value of the detached bark, if there is any regular market for it, will, after deduction of the cost of removal, drying, and separate export, always exceed the net depreciation suffered by the firewood in consequence of loss of weight and volume due to the peeling.

Some of the best known barks used by tanners are those of *Acacia arabica*, *Terminalia tomentosa*, *Cassia auriculata*, *Rhus Cotinus* and *Rhus mysorensis*, *Garuga pinnata*, *Zizyphus xylopyra*, *Buchanania latifolia*, *Bauhinia purpurea* and *Bauhinia variegata*, *Albizzia procera*, alders, *Quercus incana*, and *Phyllanthus Emblica*.

Tannic acid is not the only product from the bark of trees that serves the purpose of curing leather. The well-known softness, peculiar scent, and water-proof quality of Russia leather are due to its being impregnated, after it has been tanned, with the essential oil distilled from the outer white bark of the birch. Amongst our numerous species some are sure to be found capable of yielding a similar oil.

Section II.—Bark for dyeing.

Irrespective of tannic acid, which with salts of iron gives various shades of green, purple, maroon, grey, and black, almost all our barks yield, by mere decoction, a large proportion of other colouring matters, some of them red and yellow, but most of them giving some shade of brown. Contrary to tannic acid, most of these colouring matters reside in the rhytidome, so that the older a tree is, the larger will be the amount of colouring matter present in its bark. It is principally these colouring matters which cause a difference in the colour of leather, according to the species of bark used. Up to the present, scientific dyers have not taken up a study of our various tree-barks, and hence their capabilities as dyeing materials for use on a large scale are still only a matter for the future to reveal. All the dyes are permanent. That these dyes are likely to be greatly fancied the moment they become known seems certain from a casual use of the brown dye obtained in bleaching the fibre of *Bauhinia Vahlii*. Mr. Wilson, the gentleman who experimented with the fibre in England, employed the colour in dyeing silk, and produced some elegant shades by different reactions. The bark of *Acacia arabica*, *Hardwickia binata*, *Soymida febrifuga*, *Terminalia tomentosa*, and sál are well known to yield extremely rich browns.

Section III.—Fibres.

All woody species yield fibre, but it is only a very few, of which

the fibres are strong enough to be twisted without breaking, and the number is still smaller of those the ultimate fibres of which, remaining after the cleaning and bleaching processes, are long enough to be spun. All fibres suitable for cordage and spinning are also excellent for paper-making, for which a great many others also are well adapted. The fibre of the living bark alone is fit for use. The woody species whose bark yields utilizable fibres belong almost exclusively to the Malvaceæ (*Hibiscus*, *Thespesia*, *Kydia*, *Adansonia*), the Tiliaceæ (*Grewia*), the Sterculiaceæ (*Sterculia*, *Helicteres*, *Eriolæna*), the Urticaceæ (*Bœhmeria*, *Pouzolzia*, *Sarcochlamys*, *Maoutia*, *Debregeasia*, *Broussonetia*, *Antiaris*, *Ficus*, *Ulmus*, *Sponia*), the Leguminoseæ (*Sesbania*, *Desmodium*, *Bauhinia*, *Hardwickia*), and the Asclepiadeæ (*Calotropis*, *Marsdenia*, *Pergularia*). *Careya arborea* and *Daphne papyracea* are two well-known exceptions to this rule. Amongst the Monocotyledons several palms yield fibre.

In all the dicotyledonous species the bark has only to be stripped off in as long ribbons as can be taken off, a certain amount of pounding or beating being necessary to loosen it. In the case of *Bauhinia Vahlii*, however, owing to the peculiar structure of the stem, the stem has first to be first split up into long thin strips, and then pounded until the bark separates from the numerous enclosed wood strands.

Among the woody Monocotyledons, the chief of our fibre-yielding species are the cocoanut palm, from which we obtain *coir* (the fibre surrounding the nut) and the fibre of the leaves and sheathing leaf-stalks, and the *Caryota urens*, the leaves and sheathing leaf-stalks of which give the strong *Kittul* fibre, which is made into ropes, brushes, brooms, baskets, &c. The cord-like fibre obtained from the interior of the stem of the cocoanut, palmyra, Caryota, and other palms, may also serve important uses.

SECTION IV.—OTHER USES OF BARK.

Many barks are used for medicinal purposes, owing chiefly to the alkaloids they contain. The most universally used of such barks is that of the various Cinchonas, which, although exotics, are now cultivated on an extensive scale in plantations treated mostly on the coppice system on very short rotations. Some barks are used for special industrial purposes, those containing gelatinous secretions or tannic acid serving, in many cases, for clarifying sugar. The gelatinous matters coagulate with heat, thus separating from the liquid and carrying away with them the minutest impurities, while the tannin, by coagulating the albumi-

nous matters present, has the same effect. The bark of the *Acacia leucophlæa* is used in the distillation of spirits, the tannin causing the albuminous matters to be precipitated.

Exceptionally, mere temporary huts are sometimes covered with bark, and cheap umbrellas in Upper India are made with the bark of the Bhojpattra. Moreover, the thick corky bark of *Pinus longifolia* is made into charcoal, which is more highly prized than wood charcoal by blacksmiths in the Western Himalayas.

CHAPTER IV.—UTILIZATION OF THE LEAVES OF TREES AND SHRUBS.

The leaves of trees and shrubs are used principally for fodder, manure, litter, and thatching. On a smaller scale they yield drugs (nim, *Vitex Negundo*, senna, *Adhatoda Vasica*, &c.), material for dyeing (Indigoferas, *Lawsonia alba*, &c.), and tanning (*Anogeissus*, *Rhus*, &c.), and for matting, basket-making, and paper manufacture (various palms). The number of species which serve these last mentioned purposes is, however, so small, and the quantity of leaves that is actually used, or is ever likely to be required, is so insignificant, that arrangements for meeting the demand for them, without injuring the stock or the resources of the forests, will never present any difficulty.

SECTION I.—LEAVES FOR FODDER.

For fodder, leaves must of course be plucked or lopped green, as otherwise they would have no nutritive value. Moreover, the leaves of most fodder-yielding species are relished by cattle only while they are young and tender, as they afterwards either become too tough and fibrous or acquire an unpleasant flavour. It is scarcely necessary to say that only broad-leaved species yield fodder.

The nutritive value of tree-fodder, as compared with that of the best meadow grass, is as 100 to 125. Lopped twigs and small branches contain from 40 to 60 per cent. by weight of leaves and edible stem-portions.

The practice of lopping is always harmful. Besides robbing the plants of assimilating organs and causing disfigurement and introducing the germs of unsoundness, it deprives the soil of manure more valuable than that furnished by the grass growing under them. This higher value is due to the leaves being less fibrous and decomposing more readily, and also to the fact that the total mass of leaves produced by canopied trees is larger than the entire

quantity of grass growing below. Moreover, leaves are extremely rich in nitrogen and contain up to 8 per cent. of ash, a very large proportion of which consists of potash and phosphates. When wood alone is utilised, nearly all these constituents, which have been collected and brought to the surface by the roots from an immense thickness of soil, are left on the surface to enrich it, and the same matter is thus repeatedly used, year after year, by successive generations of trees. If we remember this fact, and also that it is the dead fallen leaves alone which can, by their decomposition, draw fresh supplies of nitrogenous substances from the atmosphere, and convert refractory compounds of potassium, calcium, and magnesium present in the soil into soluble and assimilable constituents of plant-food, it is evident that the continued removal of the leaf-production of an area injures it not only in the present, but even more so also for the future, and that the injury is greater in proportion to the natural infertility of the soil. Sooner or later, the evil consequences of removing leaves become apparent in the languishing growth of the forest. In a sandy soil, the most careful conservation in other respects will fail to make the trees attain their normal size or grow close enough together to form a leaf-canopy. In very rich soils, the trees may still attain their usual size and form a dense growth, but at a comparatively early age they will begin to decay at the centre, so that they will be unable to furnish timber of any size.

The evil effects of lopping are thus extremely grave and incontestable, and yet we have to permit its continuance in many of our forests in consequence of admitted prescriptive rights. In the higher ranges of the Himalayas, the maintenance of these rights is doubtless unavoidable on account of the severity of the climate during the winter and early spring, when the leaves of trees are almost the only kind of fodder available. But in all other places the right of lopping for fodder is totally unjustifiable, as it only gives encouragement to improvidence. It is true that the leaves of trees are actually lopped only when the grass on the ground is dry and wanting in nourishment, but there is nothing to prevent the same grass being cut in time and converted into hay in anticipation of the coming dry season when the standing dry grass will not be fit to be eaten.

No effort should therefore be spared to suppress, whenever possible, the practice of lopping. Where we are powerless to stop it entirely, it should at least be restricted within the narrowest possible limits, and be regulated on lines having for their objective the safety of the trees lopped. In forest regions rich in species,

there will nearly always be many kinds which are more or less useless from the point of view of timber and firewood, but which yield good fodder. Every endeavour should be made to confine the lopping to such species, and even then the lopping should be effected in such a way as to maintain, to the fullest extent possible under the circumstances, the productive power of the trees lopped. A tuft of foliage at least 5 to 10 feet deep, according to the height of the trees, should be left, and the branches below this level should be cut, with sharp tools, with a clean section, in order to prevent unsoundness and to enable the buds at the base to throw out new vigorous shoots. If the quantity of leaf fodder to be furnished is large, a regular rotation of from 2 to 5 years should be established, the forest being divided into as many blocks, of which only one at a time is to be kept open for lopping. Advantage should be taken of the trees and poles to be removed in the ordinary course of fellings, by allowing them to be lopped for several years preceding their exploitation, thus furnishing at once a not inconsiderable portion of the total amount of fodder required. In coppiced forests, the entire stock of a coupe may be lopped just before it is felled.

When the amount of lopping admissible is very heavy, and it is found difficult or impossible to regulate and control it without serious injury to the forest, the best plan is to set aside a portion of the area exclusively for fodder purposes, and in this area to pollard the trees, either every year or after the lapse of a recurring number of years, according to the system of pollarding adopted.

The leaves of trees and shrubs, like grass and the leaves of pulse crops, may also be dried and stored up for future use. The leaves of various species of *Zizyphus* are used in this way. As a rule, dried leaves make very poor fodder for cattle, but sheep eat them with avidity and thrive on them.

SECTION II.—LEAVES FOR MANURE.

The practice of using vegetable ashes as manure for field crops is one that dates from pre-historic times. The original inhabitants of India probably grew nearly all their crops in forest clearings in the ashes of the felled trees and other vegetation. In spite of injunctions in the Vedas to save forests from fire, the Aryans adopted the customs of the aborigines, in the hilly regions where forest vegetation grew in luxuriance. Even in the plains, where cultivation made rapid progress, the idea that leaves and branches supply valuable ash was not forgotten, and the jungle was cut and spread over the fields, where it was burnt. In this manner, pre-

scription has established rights which the present Government has in most cases, with certain restrictions, admitted. The exercise of such rights being more universal even than lopping for fodder, and one that is, in the opinion of the people and a powerful section of the official class, identified with successful agriculture, is so much the more difficult to suppress, although it is utterly indefensible and is always followed by the gravest consequences.

The only system of using tree-loppings for manure, of which any serious defence has ever been attempted, is that called *rab* in the Konkan districts of Bombay and *beta* on the Malabar coast and in Mysore. It prevails especially in districts where the wet cultivation of rice is practised and the seedlings are transplanted from a nursery, and consists in preparing the seed-beds by burning layers of cowdung or brushwood with subordinate layers of leaves, grass, rice straw, and earth, in other words, in using a kind of surkhí ash for manuring the seed-beds. For this system it is contended that it is the only one which gives good and certain results in the peculiar circumstances in which those districts are placed. These circumstances are (1) the absence of heavy showers before June, when it is necessary to raise the seedlings if they are to be really strong at the time of transplanting; (2) the very heavy early rainfall; (3) the heavy continuousness of the early rains; (4) the early closure of the rains; (5) the absence of rain from the North-East Monsoon; and (6) the absence of facilities for water-storage. Owing, it is said, to these peculiar conditions, seed cannot be sown until the rains have set in, and the seedlings have to be forced, so as to enable the crop to mature within the short period during which the rain continues. Professor Wallace of Edinburgh has lent his powerful name in support of this system, but by merely re-echoing the opinions he heard in Bombay. There is really no reason why the rice cannot be forced by other means. A very simple expedient, which would help very much to shorten the time the crop would require to be on the ground, would be to force germination before the seed was sown.

In Southern India sugarcane fields are also often rabbed on account of the large quantity of manure required by this class of crop. A system of rab was once largely practised in parts of Central Europe and supported by arguments just as specious as those now employed in India; but these arguments could not stand before the march of science, and what was once considered a necessity has now received unqualified condemnation on every side.

Even if we assume, for the sake of argument, that the burning of leaves on the surface of seed-beds is necessary, it is impossible

to understand why dead fallen leaves should not fully serve the purpose. Whether we burn the leaves taken off green or collected only after they have been shed naturally, the ash constituents left behind, after the burning, are practically the same. But, on the other hand, for the forest itself, the removal of green leaves means arrested vegetation and the irretrievable loss of all proteid matters and starch, besides whatever other useful constituents dead leaves contain. There is hence no reason why lopping for rab should not be stopped, even if vigorous rice seedlings cannot be produced without burning leaves on the surface of the beds, for dry leaves could take the place of the green material. The only excuse for rab thus seems to be that the green leaves, being attached to the branches, are more conveniently collected and carried than dead fallen leaves.

In the outer Himalayas, loppings of broad-leaved trees are spread over ginger and turmeric fields as a mulching and to keep the soil loose and warm. At the same time they enrich the soil by their decomposition. But there is no reason why a mulching of straw would not be as effective, while the manurial properties of the leaves could be made good by applying an additional quantity of other manures.

The day must come when, with the march of progress and wealth, this very primitive practice of using the leaves of forest trees for manuring fields will be discontinued, just as the barbarous system of clearing and burning the forest for cultivation has already given place to settled agriculture. Until then, however, we must resign ourselves to arrange for its continuance with the least possible injury to our forests. In the first place, whenever we can do so, we ought to substitute dead fallen leaves for green lopped branches. In the next place, the practice should be rigidly excluded from all areas intended for the production of timber. In fuel forests, the adoption of the coppice system on short rotations should be taken advantage of to furnish a large supply of small branches and leaves at each exploitation; and to save people from coming long distances, there should be numerous small working-circles. The establishment of such small circles of course means excessively detailed work and a large staff, and therefore heavy expenditure. But Government must be prepared to face these drawbacks, if it rules the continuance of the cause thereof. In mere grazing reserves, the same rule must be adopted as for fodder-lopping, namely, restriction of the lopping to definite species and maintenance of a crown at least 5 to 10 feet deep. Where there is a mass of low shrubby vegetation, such vegetation may be cut back once every two or three years,

a short rest being given to enable the soil as well as the root-stocks to recover.

The regulation of the removal of dead fallen leaves and the influence of the practice on the forest are described in the next Section.

SECTION III.—LEAVES FOR LITTER.

The leaves of broad-leaved species, when they die and fall off, become so brittle and rot away so quickly, that the only dry leaves that can be used for litter are the fallen needles of conifers. When the leaves of broad-leaved species are cut green and then dried and spread under cattle, the object is more that of providing fodder and of using the leaves directly as a manure than of obtaining an absorbent medium for the easy and convenient collection of the droppings and urine of the animals. Thus nothing more need be said here regarding the use of the green leaves of trees and shrubs than what has already been given in the immediately preceding Section, and consideration must hence be limited exclusively to the utilization of conifer needles.

The needles of the *pine* tribe, as they contain the largest proportion of fibre, are the best adapted for litter. On the other hand, the needles of the other species of conifers which grow on an extensive scale, namely, the firs and deodar, and in certain parts of the Himalayas, also the larch, yield almost as much ash as the leaves of most broad-leaved species, and have, therefore, a high intrinsic manurial value.

The sweeping away of the entire annual fall of leaves is obviously fatal to the productiveness and maintenance of the forest. But since conifer needles decompose very slowly, and, unless crushed by artificial means, form a thick covering over the ground which prevents all reproduction by seed, the raking away of a portion of the annual fall is more beneficial than hurtful. The operation in question not only diminishes the thickness of this obnoxious covering, but also helps to crush whatever portion of it is left unremoved.

The injurious effects following the removal of the layer of dead leaves covering the soil are greatest (1) on sloping ground, especially exposed hill-sides, since the soil there requires all the protection that can be given it to prevent erosion and impoverishment by the rapid downward filtration of water; (2) on bad soils, in a forcing climate, with naturally quick-growing species, and in youth and in old age, for in all these cases the presence of a large quantity of plant-food in the soil is an absolute necessity; (3) in open forest,

where of course every bit of the exiguous annual leaf-fall must be preserved; (4) in coppice, in which class of forest the soil is more or less completely exposed during half the rotation, so that the protection of the fallen leaves is an absolute necessity during that half, and their preservation and conversion into humus under the leaf-canopy during the other half is the only means of maintaining the productiveness of the soil; and (5) during the season of vegetation, when the soil must be in the most favourable condition possible.

In regulating the removal of dead leaves, two precautions must never be omitted: (1) a rotation must be established, and (2) measures must be taken to ensure a part of the annual fall being left on the ground. The length of the rotation will depend, principally, upon the nature of the soil and locality and the largeness of the demand, and, secondarily, upon the component species, the age of the crop, and the method of treating the forest. The more unfavourable the soil and locality and the heavier the demand, the longer must be the rotation. So also a young or an old crop, an exacting species, and a system of treatment which exposes the soil for long intervals, will require a long rotation. The saving of some portion of the annual leaf-fall is ensured by allowing the dead leaves to be collected only *while* they are falling and *only during the first half of this period.* A combination of the two precautions in question will never fail to result in a considerable quantity of leaves being left on the ground to decompose and form humus and enrich and improve the mineral soil below.

SECTION IV.—LEAVES FOR THATCHING.

Where palms grow in abundance, the leaves often form the entire thatching put into a roof. Before using the leaves, they should be placed over one another, on a dry floor, with the leaflets properly spread out, so that they may dry quickly and well flattened out. When dried thus, they are easily arranged over one another in the roof. If the leaflets are long and narrow, like those of the cocoanut palm, they may be plaited together into a sort of matting. Palm thatching seldom requires renewal oftener than once in three or four years, and then too it is only the upper layers that need replacement. Thatching composed of leaves of the *Wallichia densiflora* is extremely durable.

The leaves of other species, and also often of palms, are laid under or between grass thatch. By increasing the tightness of the roof, they enable it to be made extremely thin and light. Before the leaves can be used, they must be dried, after being pressed to-

gether and tied up in bundles. The leaves of teak and of *Bauhinia Vahlii*, especially the former, are extensively so used and constitute an article of considerable export. Any broad fibrous leaf serves for thatching, and accordingly the leaves of many other species, such as *Butea frondosa*, *Semecarpus Anacardium*, *Diospyros Melanoxylon*, &c., are often used in the vicinity of forests. Matting of palm leaves is often placed directly over the timbers of a roof before the grass thatch is put on and lasts for more than ten years.

SECTION V.—LEAVES FOR TANNING.

The leaves of a few species, such as *Anogeissus latifolia*, *Rhus Cotinus*, &c., are used in tanning. The leaves should be collected only when they are mature, but while they are still full of sap and before their colour changes previous to their being shed. The change of colour results from the appearance of colouring matters, which have their effect on the leather. Hence for white or light-coloured leathers there ought to be no delay in picking. The highest quality of leaves is obtained nearest the ends of the branches. After being picked, the leaves should be first wilted, then spread out and quickly dried, either in the sun or on racks arranged one above another in a heated room. To accelerate the process, the leaves should be frequently turned. Leaves properly dried should be greenish. For convenience of export, the leaves should be ground into a coarse meal.

The dried leaves of the various species of Rhus used for tanning contain 16 to 24 per cent. of gallo-tannic acid, and make a soft, pale-coloured leather. The leaves of Anogeissus give a similar leather, and the samples analysed by Professor Hümmel yielded 15½ per cent. of tannin, while those of the leaves of *Phyllanthus Emblica* gave as much as 18 per cent. The decoction of the leaves of both these species obtained by the Professor was of a pale yellow colour and slightly turbid.

SECTION VI.—SOME OTHER USES OF LEAVES.

The leaves of *Melaleuca Leucadendron* yield the Cajuput oil of commerce. The leaves of *Terminalia Catappa*, *Baccaurea sapida*, and some other species are used in dyeing, those of the first giving a black dye. The leaves of *Butea frondosa*, *Bauhinia Vahlii*, and *Cordia Myxa* are very largely used by Hindus in the place of plates and cups. The plates are formed of several leaves pinned together with long spines or stiff grass stalks, while the cups consist of one or several leaves bent and pinned to the proper shape. The same

leaves are also used by shopkeepers to wrap round grocery and other small articles that they sell. For these various purposes the leaves in question are exported to great distances. The leaves of the plantain are also used for plates. Both the leaves of the plantain and of species of Bauhinia take the place of paper in the cigarettes smoked by the people of the Western Coast, while the leaves of Cordia are used to cover Burmese cheroots. The dried leaves of nim, *Vitex Negundo*, and some others are used as insectifuges. Pine needles, digested in a solution of caustic soda, yield more than 80 per cent. of their dry weight of a fine fibre (*pine wool*), which is made into felt and is woven into cloth resembling woollen fabrics.

CHAPTER V.—UTILIZATION OF MINOR PRODUCE OBTAINED FROM FELLED WOOD.

The stem, besides yielding major produce, *viz.*, timber, firewood and wood for charcoal, furnishes many other useful products that are extensively used. They may be grouped under the heads of (1) dyes and other extracts, (2) oils and the various products of distillation, and (3) starch.

SECTION I.—DYES AND OTHER EXTRACTS.

The heart-wood of every species owes its colour to a substance or substances which can be used in dyeing; but these substances must be capable of being extracted with ease and in sufficient abundance to have a commercial value. In spite of the very slight knowledge possessed by our dyers of the various modes of manipulating dyeing substances, a great many dye woods are already used by them as well as by the general population. The Jack wood, *Plecospermum spinosum*, and various others yield a yellow dye. *Pterocarpus santalinus* gives a very pretty salmon-pink dye, *Cæsalpinia Sappan* and *Adenanthera pavonina* a red dye, *Cynometra ramiflora* a purple dye, and so on. But the most common colour yielded is some shade of brown. The easiest way to obtain the dye from wood that has been sawn is simply to boil the saw-dust. But for work on a commercial scale, the wood, before being boiled, would be most quickly reduced to thin shavings on a lathe.

The two best known and most widely used wood-extracts are the cutch and katha of commerce, the former being used principally as a dye and exported to Europe, the latter being chewed with betel and the betel leaf. From Upper Burma alone the annual exports, a few years before the annexation, amounted to 150,000

maunds, valued at Rs. 11,00,000. Since then, owing to restricted cuttings in consequence of reckless utilization during the late dynasty, they have diminished 50 per cent. in quantity and about 40 per cent. in value. In Lower Burma, in two Divisions alone (*viz.*, Tharawaddy and Prome), the annual revenue from cutch is not less than half a lakh of rupees. In India proper, the manufacture is on a much smaller scale; nevertheless the quantity carried by rail and river in 1888-89 was over 33,000 maunds, valued at Rs. 5,00,000.* Many of our dark-hearted trees, such as *Hardwickia binata*, *Soymida febrifuga*, &c., would, no doubt, yield dyeing extracts quite as valuable as cutch. Industry and enterprise alone are wanting to bring them into use.

SECTION II.—OILS AND OTHER PRODUCTS OF DISTILLATION.

The oils at present distilled from wood are those obtained from sandal-wood, from teak, from deodar, and from pines (chiefly *P. longifolia*, *Khasya*, and *Merkusii*).

Amongst these, the only articles of commerce are the produce of the sandal-wood, *Pinus longifolia*, and teak, the rest either having a very local use or being manufactured to meet an occasional demand.

The process of manufacture of sandal-wood oil will be described in Part III. A large quantity of wood is now wasted which would profitably be used for distilling the oil, and the establishment of stills in all the sandal-wood forests of Madras, Mysore, and Coorg would permit of those forests being worked and treated on a much more intensive system than can be adopted under present circumstances.

The oil of the deodar and *Pinus longifolia*, as well as of teak, is obtained by destructive distillation. The method of distillation is extremely primitive. Chips of the wood, long enough not to fall out, are put into an earthen pot with a narrow mouth. The chips are set on fire, and the pot is inverted into another, with a broad mouth. As the wood burns, the vapour of the oil condenses against the sides of the upper pot and the oil trickles down into the lower one. Sometimes the wood is not set on fire, but the two pots are so arranged that the inverted one is surrounded with fire. In either case, the produce obtained is never quite pure, as tarry matters and acids distil with the oil and discolour and taint it. This is, however, actually no disadvantage in the case of the conifer oils, which are at present used only for friction in rheumatism and skin diseases. Teak wood oil is rubbed into inferior woods to make them more durable and to give them the odour and oiliness of teak wood. In each one of these cases, tarry matters and a small quantity of acid probably add to the effectiveness of the oil.

* For further particulars regarding cutch and katha, *see* Part III.

Teak wood oil, being siccative, is also sometimes used in the place of linseed oil.

The other products of distillation of wood, in which there is a trade, are acetic acid, wood-spirit, creosote, and tar. Of these, tar alone is made in this country, and that, too, only on a very small scale for local consumption. The method of preparing wood-tar directly has already been described on page 147, and will again be further noticed in Chapter IV. of Part III. Although wood-tar can never compete with coal-tar in the general market, there is still plenty of room for its more extended use in and near the areas where deodar and pines grow.

The method of dry-distilling wood will be explained under the head of charcoal-burning in Part III. The acetic acid obtained directly from the distillation is full of various other products, and is in that condition termed pyroligneous acid. The pure acid is separated in the form of an acetate of lime, which is then heated with sulphuric acid, or, better still, hydrochloric acid, the base going to form sulphate or chloride, as the case may be, and setting free the acetic acid. Acetic acid is a powerful solvent of various organic bodies, camphor, resins, essential oils, phosphorus, &c. It is extensively used in the treatment of gums, caoutchouc, and various albuminous substances, in the manufacture of paints and varnishes, and as a drug. The uses of vinegar are well-known. The crude pyroligneous acid, owing to its containing creosote and other hydro-carbons, is a powerful antiseptic. Finally, acetic acid forms a series of salts, or "acetates," of special value in calico printing, dyeing, and other branches of industry.

Wood alcohol is, however, the most important product of the dry distillation of wood and constitutes about 1 per cent. of the distillate. Combined with sugar alcohol in the proportion of 10 parts to 90 of the latter, it becomes the methylated spirits of commerce, a product of such wide use in the arts and manufactures and in the scientific laboratory. Bleaching powder acting upon wood spirits produces chloroform. Ether is prepared by heating alcohol with sulphuric acid.

The products of the dry distillation of wood comprise, besides the substances already mentioned, all the substances, such as paraffin, benzene, &c., yielded in much larger quantities and at infinitely less expense by the distillation of coal.

SECTION III.—STARCH.

The only woody Indian species from which starch is extracted are a few palms, such as *Caryota urens*, *Phœnix acaulis*, Arenga, and Corypha. This starch is, however, only consumed locally

and has practically no market value. But there is no reason why it should not become an article of trade. Owing to the peculiar structure of the stems of palms, the centre consists entirely of cellular tissue rich in starch, the quantity of which is generally largest towards the base, where the reserve materials are principally stored up. The starch is easily separated from the tissues containing it. These tissues are crushed and well rubbed and washed in water. The whole is then thrown upon a fine sieve, through which the starch passes with the water. The water is evaporated and only the starch remains.

CHAPTER VI.—UTILIZATION OF MINOR PRODUCE FROM WOODY ROOTS.

The roots of woody plants yield (*a*) food for man (*e.g.*, yams, *Pueraria tuberosa*, &c.; (*b*) drugs (*e.g.*, *Strychnos Nux-vomica*, *Hemidesmus indicus*, *Cissampelos Pareira*, mudar, some barberries, &c.); (*c*) fibres (*e.g.*, *Butea frondosa*, the aërial roots of some figs, &c.); (*d*) dyes (*e.g.*, chay or *Hedyotis umbellata*, known as Indian madder; *Rubia cordifolia*, yielding *manjit*, a product much resembling madder; *Morinda citrifolia*, yielding a scarlet dye, species of *Berberis*, a yellow dye, *Ventilago Maderaspatana* orange by itself, chocolate with chay, and black with galls; and so on). Many edible wild roots contain some acrid principle which can be got rid of only by long boiling. The fibres of the roots of the *Butea frondosa* are easily separated by beating the whole root with the back of an axe. These fibres, however, make only very coarse cordage which becomes brittle in drying. Strips of the fresh-cut root are used for tieing up thatch.

CHAPTER VII.—EXUDED PRODUCTS.

These are very numerous and of extreme importance. They may, for our purpose, be divided into (1) sugary sap, (2) gums, resins, and varnishes, and (3) rubbers.

SECTION I.—SUGARY SAP.

The utilization of such sap is the basis of a very extensive industry. In India, the palms are the only family which contain trees that yield sugary sap. Those usually tapped are the cocoanut and palmyra palms, the *Caryota urens*, the *Arenga saccharifera*, the *Nipa fruticans* and the wild date palm. The first four yield juice from the cut stalk of the inflorescence before the flowers appear, the last from incisions made in the stem at the base of the lower leaves, which are cut off. The sap, or toddy as it is called, of these palms, flows in abundance. While it flows it is collected twice a day, the daily yield varying from a pint or two to several gallons. Nearly every spathe may be tapped, and the yield, there-

fore, depends on the number of spathes developed or cuts made. The same spathe or cut goes on giving toddy for nearly half the year; but periodically, about once, twice, or thrice a week, a thin piece has to be sliced off to freshen the wound. In the case of the wild date palm, the sides of the incision are freshened once a day for three days running each week, and the quantity of juice collected in the morning after each re-cutting is, in Bengal, respectively 16, 6½, and 3 pints. During the three remaining days the outflow is insignificant and the trees are allowed to rest before being cut again.

The toddy is largely drunk; but the greater portion is fermented and made into spirits and vinegar, or boiled down into raw sugar, which is refined at Cossipore in Bengal and in many places in the Madras Presidency. Toddy is nearly as rich in saccharine matters as cane juice, and as, unlike this latter, it is entirely free from colouring matters, chlorophyll and other impurities, the sugar it yields is much easier to clarify. The proportion of gur obtained from date juice averages one-tenth by weight. The palm gur, as actually made, contains a large proportion of gluten, which causes it to deteriorate sooner than cane gur.

Section II.—Gums, Resins, and Varnishes.

Gums are degradation products of the secondary cell-wall. The essential constituents of gums are *arabin*, *cerasin*, and *bassorin*, and according to which one of these three is present or preponderates, we have gum, arabic, cherry gum and gum tragacanth. Other constituents of gums are dextrin, sugar, tannin, colouring matters, and mineral ingredients. The various kinds of gum arabic, the type of which is obtained from several species of Acacia, are readily soluble in water at all temperatures and have the same composition as starch. They are the only gums which can be used for adhesive purposes. Cherry gum, to which category belong the exudations of *Bauhinia Vahlii* and *Thespesia populnea*, is insoluble in water, but absorbs it greedily and swells up into a transparent jelly-like mass. Boiled with a small quantity of some alkali, it is converted into gum arabic. Gum tragacanth, which is typically represented by the gum (*katira*) of the Sterculias, of *Cochlospermum Gossypium*, of *Eriodendron anfractuosum*, and of the cocoanut palm, is also insoluble in water, but, above a certain low minimum temperature, it absorbs water energetically, increasing enormously in bulk. It, however, becomes soluble when treated with an alkali. When acted upon by weak sulphuric acid, it yields a sugar that is incapable of fermentation. Most of our gums are mixed gums, that is to say, they contain two or all three of the three main constituents. Gums have various uses besides their

employment as adhesive material. They are used in pharmacy as a medium for medicaments and as mucilage for soothing internal inflammation ; also directly as a medicament itself. They are also largely employed in calico printing, in sizing paper, and in confectionery.

Resins are also degradation products of the cell membrane, but sometimes they are derived from fine-grained starch. In most species, the change into resin is brought about in those cells the vitality of which has been diminished from any cause. It is for this reason that resin is found in greatest abundance in the region of wounds, and that the stumps of felled pine and deodar trees become almost transparent with the large proportion of resin formed by the degradation of the cell-walls. Resins are soluble in alcohol, ether, and carbon disulphide, but insoluble in water. They burn with a bright or a smoky flame.

Resins may be classified into (1) true resins, (2) gum-resins, and (3) oleo-resins. The true resins are (*a*) hard or copaline, as the resins of *Vateria indica* (piney), *Hopea odorata*, *Dipterocarpus tuberculatus*, *Shorea* spp., and *Canarium bengalense*, or (*b*) soft or *elemi*, as the exudation of *Boswellia thurifera*. The gum-resins embrace three sub-classes, (*a*) the emulsive (*e.g.*, gamboge of *Garcinia Morella* and kino of *Pterocarpus Marsupium* and *Butea frondosa*), (*b*) the fetid (*e.g.*, asafœtida and the exudations of *Gardenia lucida* and *gummifera*), and (*c*) the fragrant, this last being further sub-divided into two sections, represented respectively by the exudations of Balsamodendron (bdellium) and mango, and that of the genus *Styrax* (gum benjamin or benzoin). The oleo-resins embrace balsams (*e.g.*, the gurjun "oil" of *Dipterocarpus turbinatus*, the wood "oil" of *D. lævis* and *D. zeylanicus*, and the copaiba-like balsam of *Hardwickia pinnata*), natural varnishes (*e.g.*, the lacquers of *Melanorrhœa usitata*, *Rhus vernicifera*, *Semecarpus Anacardium* and *travancorica*, *Holigarna longifolia*), and turpentines and tars (the products of numerous conifers).

Gums are found in exploitable quantity only in the bark, while resins are formed in the wood as well as in the bark. In the bark the resin always occurs in special receptacles (resin cells or ducts); in the wood there may be special reservoirs, as in pines, or the resin may be secreted in the vessels themselves, as in the wood of the Dipterocarpeæ.

According to where the resin or gum is secreted, and to whether the secretion has or has not to be artificially aided, we have three modes of collection, *viz.*, (1) collection of spontaneous exudations, (2) collection from wounds made in the bark, and (3) collection by tapping the wood.

ARTICLE 1.—COLLECTION OF SPONTANEOUS EXUDATIONS.

During the season of rest, especially when the bark becomes dry and cracks, and the tree, unable to transpire, is full of moisture, the low vitality of the numerous cells in the bark results in the formation of gum. It is also at this time that the outflow of resin is most active. The quantity of resin that bursts through the bark and exudes spontaneously is too insignificant to become an object of regular exploitation, and hence only gums are thus collected. Gums obtained in this manner comprise those furnished by *Anogeissus latifolia* and some of the Acacias, especially *A. arabica*. The yield of gum is largest after a forest fire, which not only reduces the vitality of the trees, but also enlarges existing tracks and creates new ones. The prolonged hot dry weather which precedes the setting in of the summer rains, however, suffices to produce a large quantity of the degradation product, chiefly in the more unhealthy trees; and we have thus a means, without setting fire to our forests and injuring growing timber, of deriving some sort of utility from trees, which, although they hold out no promise in respect of wood production, cannot, for some cultural reason or other, be removed.

ARTICLE 2.—COLLECTION FROM WOUNDS MADE IN THE BARK.

This mode of collection is employed chiefly in obtaining the kino of *Pterocarpus Marsupium* and *Butea frondosa*, the gum of *Bauhinia retusa* (semla), and, in poor forests, also of *Anogeissus latifolia*, and the exudations of the Garcinias. In the case of all but the last, vertical rows of parallel, slightly oblique gashes, a few inches long and about 6 inches apart and penetrating as far as the wood, are made in the bark, all round the stem, and also round the main branches of small trees. The exudation collects generally in long or globular tears. It is allowed to harden on the wounds and is then broken or scraped off.

The semla is subjected to a very systematic utilization. The trees are tapped twice in the year, *viz.*, during the dry seasons preceding respectively the summer and winter rains. The gashes are cut in March-April and September-October, and the gum collected in May-June and November-December. A rest of from one to two years after each year of exploitation suffices to enable the wounds to heal over and the trees to recover completely. According to Babu Karuna Nidhan Mukerji, the average yield per tree is about 5 seers of gum, which sells in the Dehra Dún bazar at an average rate of Rs. 3 per maund of 82 lbs. The semla gum, like that of *Anogeissus*, is used in calico printing and is also eaten. The yield of kino from *Butea frondosa* is about the same as the yield of gum from the semla, while that from Pterocarpus trees, which

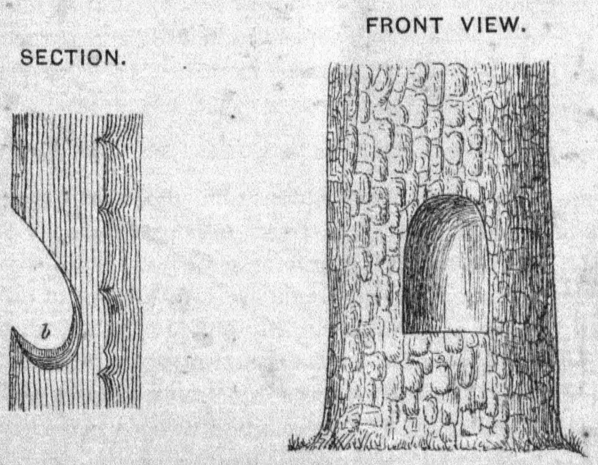
often attain an enormous size, is, no doubt, very much larger. The firs give resin only from the bark, but the yield is so small, that in the present state of the market it does not pay to tap those trees.

The true gamboge is not collected in India, although the tree which produces it, *Garcinia Morella*, grows in the forests of South India. In Ceylon the tree is tapped thus. Thin slices are cut off the bark here and there. On the flat space thus exposed the gum collects and is scraped off when sufficiently dry.

ARTICLE 3.—COLLECTION FROM WOUNDS IN THE WOOD.

This is the only mode of collecting the resins of the Dipterocarpeæ and of pines. The native method of tapping both families of trees is to cut one or more deep niches, according to the size of the tree, into the stem, at about 4 feet from the ground (*Fig.* 63). The height of the niche is about 18 inches and the

Fig. 63.



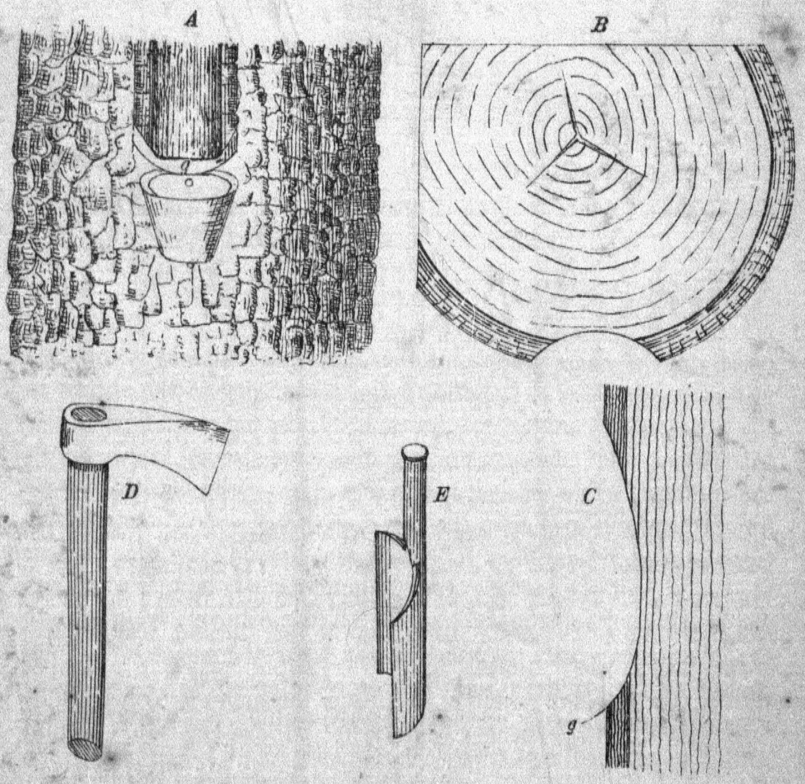
Niching Pinus longifolia *for resin.*

width at the opening about 1 foot. At the bottom it is hollowed out into the form of a deep bowl (*b* in Section) to receive the resin that runs down the sides. This hollow is emptied as fast as it fills up ; in the case of *Pinus longifolia*, once in from 4 to 10 days when the niche is first made, and at longer intervals afterwards when the outflow diminishes. The Diptercarpeæ are tapped during the dry hot months preceding the summer rains, *Pinus longifolia* during February-June, after which the resin, although it continues to flow, does not do so fast enough to tempt the collector to extend his work into the rains. In the pine a niche is worked for two and three consecutive seasons, unless a forest fire occurs and chars all the inside ; and the yield is from 3 to 6 lbs. the first year, a little more than half that quantity the second year,

and almost as much the third year. From time to time, however, the resin encrusting the sides of the niche must be scraped off and the wound freshened. The method of tapping just described obviously injures the stem, and as the object of the tappers is to obtain the largest quantity of resin, the pines always suffer in their growth if they do not become sickly and die. It has been found that more than one niche in a tree up to 18 inches in diameter kills it. The open niche also allows bark and other impurities to fall into the turpentine.

Since 1887 systematic tapping operations have been carried on in the *Pinus longifolia* and *P. excelsa* forests in Jaonsar. An attempt has been made to follow the system employed in the tapping of the cluster pine in the west of France; but as the French curved-bladed axe (*Abchot, Fig.* 64 *D*) was found too

Fig. 64.

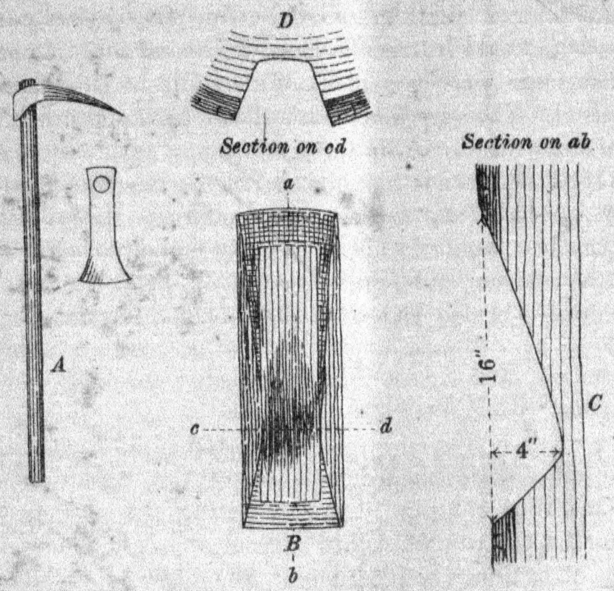


French method of tapping pine for resin.

A.—Blaze in full operation.
B.—Blaze shown in horizontal section.
C.—Blaze shown on a longitudinal section.
*D.—*Abchot *or curved-bladed axe.*
E.—Curved chisel for making incision for admission of zinc gutter g *in A.*

heavy by the hill-men, the blaze has been made with the ordinary hill adze (*Fig.* 65 *A*). It would, however, be easy enough to

Fig. 65.



Departmental method of tapping the Pinus longifolia *in the Jaonsar Division, School Circle, N.-W. P. and Oudh.*

A.—Hill adze (weight under 2 lbs.)
B.—Blaze in elevation.
C.—Section on a. b.
D.—Section on c. d.

get lighter abchots made and the men would soon get into the way of using them. Regarding the superiority of the abchot to the adze there can be no question. It is more than twice as expeditious and effective, and for the same size of blaze injures the tree less, while the gently sloping edges of the blaze get more quickly covered over with the new deposits of wood (compare sections in *Figs.* 64 and 65). Then, again, in using the adze there is always risk of the tool working obliquely towards, and exposing, the heartwood, and the sides of the blaze can never, from time to time, be freshened by the removal of a layer of wood, a mere fraction of an inch thick, as can be done with the abchot. *Fig.* 64 *D* represents a blaze in operation, with a zinc or galvanised iron gutter *g* fixed into the stem at the base of the blaze and a pot suspended immediately below, into which the resin drops from the gutter. The blaze, which has a nearly constant width of a little over 5 inches to begin with, should be made about 16 inches long.

In Jaonsar it is given a depth of 4 inches near its lower extremity (see *Fig.* 65 *C*). The depth is excessive, but it is impossible to make a shallower cut with the wretched adze used. The adze or abchot, whichever is employed, should always be almost as sharp as a razor, as a blunt edge, instead of cutting the resin ducts with a clean section, would bruise and lacerate the surrounding walls and thus choke up the entrance to the cavities. To preserve the edge of the tool, the dead, rough bark should be removed with an ordinary axe, and all old dry resin scraped off with a khurpa before using it. In Jaonsar the receiving pots were originally of iron, but they were so frequently stolen. that they are now made of ordinary baked clay, and are practically merely small flower-pots of about one imperial pint capacity.

As the gutter consists of only a thin flexible metal plate (*Figs.* 64 *A* and *C*, *g*) a groove is made to receive it with a curved chisel (*Fig.* 64 *E*). The metal plate is inserted into this groove and driven home with light blows.

Once a week, and even oftener when the resin flows very freely, the blaze must be freshened, as some of the exudation dries on the surface, thus clogging it and arresting the outflow of resin. In freshening the wound, a thin slice of wood, not more than the thickness of ordinary writing paper, should be taken off. At the same time that the blaze is freshened, it should be extended upwards a small fraction of an inch at a time, so that the blazes become generally longer with the advancing season.

Our experiments in Jaonsar have now gone on for three years, and there is still no point of any blaze either in *Pinus longifolia* or in *P. excelsa* from which resin is not still oozing out. In the niche system too, in the case of *P. longifolia*, the aggregate outflow during the second and third years exceeds that of the first year, and is very nearly as large in the third as in the second year. Such being the case, the extension of the blaze upwards should be effected very gradually, and when the length of any blaze becomes so great that the resin from the upper portion becomes too thick to run down freely until it reaches the gutter, a second gutter should be inserted about two feet above the first. The resin from this gutter may be allowed to drop directly on to the lower one, or a second pot may be hung on one side of the blaze and the gutter so shaped as to carry the resin sideways into it. It would not answer to suspend the second pot in a line with the blaze, for then the continued freshening of the blaze would become an impossibility, or would at any rate be extremely incommoded. If experience shows that it is desirable to extend the blazes to a

height of several yards, a series of such gutters and pots will have to be fixed one above another.

Experience both in Jaonsar and in the Punjab has proved that, although the flow of resin is most active during the season of rest and when the weather is warm and dry, it still continues to ooze out in fair, and sometimes in considerable, abundance throughout the rest of the year. Pots left hanging in winter, under the snow, have been found to have overflowed with resin. It is, therefore, for consideration whether somewhat larger pots than those now used should not be tried, and due arrangements made for carrying on operations during the entire open season. Rainy weather is no drawback at all, for water being lighter than the resin cannot prevent the pots from filling with the latter. Large pots would also necessitate less frequent visits to each tree in order to collect the exudations, and one man could then look after more trees than he does now.

The blaze system of tapping, although it is only in an experimental stage, already promises to produce a larger outturn than the niche method. The two systems, carried out with chir trees situated in one and the same area, gave the following yield in the first year :—

Average per niche,	...	...	...	7·4 lbs.
,, ,, blaze,	...	...	...	6·2 ,,

The niched trees were all large and specially selected, 20 in number, while the blazed trees numbered 3,221 and covered a whole hillside of about 200 acres only, so that many of them were quite small and not very vigorous. In the second and third years the niched trees gave respectively 4·9 and 4·5 lbs. per niche, whereas the corresponding figures for the blazed trees were 7 and 8 lbs.* respectively per blaze. Even if the blaze system did not increase the yield, it at least saves the base of the stem from complete mutilation, and as it determines a flow of resin in the trunk uniformly in every direction, it will produce more highly resinous and therefore harder and more durable timber. Mr. Mann says that a single long blaze is often made in the trunk of Khasya pine trees one year before they are felled, with the object of increasing the amount of resin in the wood. The wood of trees so treated contains 16 per cent. of its total weight of resin.

A remarkable fact brought to light by the experiments in Jaonsar deserves to be mentioned. If a blaze goes through the sapwood of the *Pinus longifolia*, the exposed heartwood soon becomes full of cracks and dries up at the surface, and ultimately the flow of resin from the blaze is almost completely arrested. In the *Pinus*

* The two last figures are only approximate, as the exact figures have not yet been communicated to the author.

excelsa, however, the outflow of resin apparently remains unaffected, even if a portion of the heartwood is removed in making the blaze.

Those of our conifers, the tapping of which is likely, in a near future, to become a large and profitable exploitation, comprise the three pines, *Khasya*, *Merkusii*, and *longifolia*, and perhaps also the *excelsa*. The aggregate areas covered by these pines are estimated respectively at roughly 200, 50, 2,000, and 100 square miles; but in these figures is probably included a large proportion of poorly stocked areas. The resin of the Khasya pine is the best, as it yields a purer oil than any other conifer resin in the world. The oil of *Pinus longifolia* is the least pure and has the least pleasant odour. It has also the great defect of not drying quickly—a characteristic which unfits it for the manufacture of varnishes. Excluding impurities, the turpentine consists of 18 per cent. oil and 82 per cent. colophony. The corresponding figures for *Pinus excelsa* are 22 and 78 respectively.

The utilization of the various turpentines will before long give rise to an important forest industry from the borders of Afghanistan to the frontier of Siam. A short account of the manufacturing processes through which the raw product passes will hence be given in Part III.

SECTION III.—CAOUTCHOUC AND ITS ALLIES.

These substances are found suspended, in the form of small granules, in the latex of numerous plants belonging principally to the *Euphorbiaceæ*, *Apocynaceæ*, *Asclepiadeæ*, *Sapotaceæ*, *Lobeliaceæ*, and *Urticaceæ*. The latex, after a shorter or longer exposure to the air, becomes coloured brown, and the granules separate of themselves from the rest of the liquid and form a solid independent mass. Caoutchouc is insoluble in water, acids, alkalies, and alcohol; soluble, but without any chemical change, in carbon disulphide. Its composition is complex, but its market value depends upon a proportionate abundance of the elastic substance, with a relative absence of a certain oxidized, viscid, resinous body soluble in alcohol, whose formation is in great measure prevented by rapid evaporation of the milk and other means of avoiding oxidation.

In India the only species tapped on a large scale for caoutchouc is the *Ficus elastica*. In Burma *Parameria glandulifera* is said to yield a product equal to the best Para rubber, and *Urceola esculenta* is described as very abundant, but not yielding as good a rubber. Both are Apocynaceous climbers. They are not tapped, but cut down, and the bark is at once stripped off and boiled. The hot water, however, causes much of the milk to coagulate inside the bark and thus reduces the yield very considerably.

The *Ficus elastica* throws out numerous large aërial roots, some of which run for many feet along the ground. Both the stem and these roots are tapped, the latter being more productive. February-March is considered the best time for tapping. Oblique incisions, about 3 inches wide across the middle, are made right through the bark. The exudations, if abundant, are received in conical cups made of folded leaves (pots would surely be more convenient and effective); otherwise they are allowed to concrete on the wound. Native collectors often allow the milk to run down into holes made in the soil. The incisions used to be made only 1 foot apart, but this was found to weaken the trees. In the State forests an interval of 2 feet is now adopted; and in tapping the same trees again, the new incisions are made between the old ones; as if these latter are opened again, not only do the trees suffer in vigour, but the yield of milk is diminished 50 per cent. If the milk is left to itself, it solidifies in about 20 days, when it is stripped off the wounds or taken out of the leaf-cups or holes in the ground, and kneaded into a ball, whence the designation of *ball rubber* for this product. *Leaf* or *slab* rubber is thus prepared. The fresh milk, collected within 24 hours after incision, is poured into boiling water, and the mixture is briskly agitated until the rubber separates and can be handled without sticking and kneaded. A more elaborate plan is to run the milk into wooden bins partially filled with water, on which the rubber begins to float after a time. The rubber, while still liquid, is removed and boiled over a slow fire in iron pans 4 to 6 feet in diameter and 2½ feet deep, two parts of water being added and the whole stirred constantly. When coagulated, the rubber is removed with iron forks, pressed, again boiled and pressed, sun-dried, and washed over with lime.

The average yield of rubber is one-third the weight of the semi-liquid latex. Ball rubber is obviously more impure than loaf rubber (the impurities often reaching 35 per cent). Owing to longer exposure to oxidation, while coagulating naturally, it also gives a smaller yield. Even when loaf rubber is made, a certain quantity of the ball kind is obtained from what collects subsequently and solidifies in the wounds. The ball rubber, when just pulled off the tree, contains about 17 per cent. of moisture, which, however, it soon loses after being rolled up and sunned.

The yield of course varies very much with the size and age of the trees and the number of aërial roots, and with the weather. Unseasonable rain may wash away almost all the latex. Middle-aged trees are the most productive. Large healthy trees have been known to yield as much as 150 to 200 lbs.; but the average yield,

in the present condition of the forests and plantations, is only about 10 lbs. per tree.

The trees require at least one year's rest between two tappings, otherwise they decline in health and may even die. Gamble recommends a rest of two years.

The total exports of India-rubber from and through Assam amounted, in round numbers, to 7,500 lbs. in 1887-88, of which 1,000 lbs. came from Bhutan and other tracts inhabited by hill tribes. The price of the rubber at Calcutta fluctuates considerably, but the average may be taken at Rs. 80 per maund, or very nearly Re. 1 per lb.

Gutta-percha is closely related to caoutchouc. The tree that yields the gutta-percha of commerce, *Dichopsis Gutta* (one of the Sapotaceæ) is not a native of India; but one Indian species, *D. polyantha*, yields a very good article, quite capable of exploitation. Mr. B. F. DaCosta claims to have discovered in the latex of *Euphorbia neriifolia* a substance having the properties of gutta-percha and capable of being substituted for it.

CHAPTER VIII.—UTILIZATION OF ANIMAL PRODUCTS.

The most important of these are lac and lac dye; silk; honey, wax, and manna; and hides, horns, bones, and ivory. Under this head may also be included hunting and fishing.

SECTION I.—LAC AND LAC DYE.

The lac insect (*Coccus Lacca*) frequents a great many species of trees and shrubs, but of these *Schleichera trijuga*, *Butea frondosa*, *Zizyphus Jujuba*, and *Shorea laccifera* are alone gregarious enough to be regularly exploited for lac without resort to artificially-raised plantations.*

* Besides the above, the following trees and shrubs are frequented by the lac insect:—

Acacia arabica and *Catechu*.
Anona squamosa.
Butea frondosa and *superba*.
Carissa Carandas.
Celtis Roxburghii.
Croton lacciferus.
Dalbergia latifolia and *paniculata*.
Dichrostacheys cinerea.
Dolichandrone Rheedii.
Eriolæna Hookeriana.
Erythrina indica.
Feronia Elephantum.
Ficus bengalensis, *cordifolia*, *elastica*, *glomerata*, and *infectoria*.
Garruga pinnata.
Kydia calycina.
Lagerstrœmia parviflora.
Mangifera indica.
Nephelium Litchi.
Ougeinia dalbergioides.
Pithecolobium dulce.
Prosopis spicigera.
Pterocarpus Marsupium.
Schima crenata.
Shorea robusta.
Tectona grandis.
Terminalia tomentosa.
Zizyphus xylopyra.

The lac insect breeds twice, and, in Mysore, even three times a year, but the spring brood yields the largest quantity of lac. As the insect can survive and form thick incrustations only on twigs of generous growth, the trees on which it is cultivated should always be pruned and lopped, in order to induce an abundant crop of strong juicy shoots. In the case of *Butea frondosa*, it will doubtless be best to adopt pollarding outright.

To cause the insect to spread over the whole tree or bush, the *brood lac*, as it is called, which is nothing more than fresh-broken lac from which the young insect has not yet swarmed out, is cut up into short pieces 6 to 12 inches long and tied up at various points in the crown, after being surrounded with a few wisps of straw in order to protect the young brood inside from injurious weather influences and to create numerous points of contact with the branch to enable the larvæ to pass over at once. The pieces should be tied up in the upper and middle branches, so that any wandering larvæ that may fall off from them may not be lost on the ground, but find a lodgment on the lower branches immediately underneath.

The brood lac may be gathered without any danger a whole fortnight before the young larvæ swarm out, so that there is always time enough to plant them on any number of trees.

The wood of the tree on which the brood lac is to be tied should not be harder than the wood of the tree from which it has been taken off; otherwise the larvæ may not be sufficiently powerful to draw nourishment from the new host. On the other hand, brood lac from harder-wooded trees may generally be safely propagated on a softer-wooded one.

As soon as the larvæ issue forth from the lac, they crowd over the whole crown, attaching themselves to wherever the bark is soft and juicy enough and soon covering the entire length of the twig with their incrustations. The male larvæ swarm out, attach themselves to the host, and begin to form incrustations round themselves exactly like the female larvæ. But when they become mature, they leave their cells to impregnate the females, now also mature. This exit of the perfect males must not be mistaken for the swarming of a young brood; lac broken off at this stage would be utterly worthless both for propagation and for sale.

The lac insect is extremely sensitive to low temperatures and to dry heat. It has also many enemies. Ants invade lac-bearing trees in numbers for the sweet excretions. They bite off the ends of the white filaments and thus prevent a sufficient supply of air from reaching the insects; but they are easily kept off by surrounding

the foot of each tree with wood-ashes or by tempting them with other more attractive food. Monkeys also break off and chew the incrustations for the same sweet substance and injure more than they can eat. The larva of a moth (*Galeria* ?) bores through the cells, devouring the juicy females. A Tinea also works its way into the cells and eats the colouring matter. No mode of protection has yet been devised against these two last pests.

What is not required for propagation is sold. This lac also is gathered before the young brood can make its appearance and exhaust the dye. In this unprepared condition the lac is technically called *stick lac*. To obtain the dye, the stick-lac is passed under a roller in order to detach the incrustation from the wood which it surrounds. The small portion still remaining is picked off with the hand. The separated lac is then crushed and washed in water, which effectually removes all the dye. The water is strained and the dye allowed to settle, precipitation being assisted by an admixture of alum or lime. The water is drawn off and the sediment collected, pressed into cakes, and dried in the sun. Cotton wool is often saturated with the dye and used by confectioners for colouring sweetmeats, and by women for rouging their hands, feet, and faces. Since the introduction of aniline dyes, the demand for lac dye has become insignificant.

The resinous portion or real lac (in this condition termed *seed lac*) is dried and placed in a long bag of fairly close-woven cotton drill. The bag is held by two operators over an open charcoal fire, which melts the lac inside. The men, one at each end, now begin to twist the bag in opposite directions, so that the melted lac is forced through the cloth and drops into a long trough underneath. From this trough, which is hot enough to maintain the lac in a molten condition, a third operator throws a ladleful on to a smooth hollow cylinder of porcelain or metal filled with warm water. Without any delay a fourth operator quickly spreads the lac evenly over the cylinder with an aloe or plantain leaf. The sheet of lac is at once lifted off, and waved about in the air for a moment or two until it is quite crisp. This is the *shellac* of commerce. The cylinder is kept warm to prevent any portion of the lac adhering to it. In Bengal, the shellac is often solidified on plantain stems. If, instead of using the cylinder, the melted lac is dropped upon a smooth plane and assumes the shape of small ginger nuts, it becomes *button lac*, which generally commands higher prices in the London market than shellac.

Schleichera trijuga furnishes the most valuable product, a bright amber-coloured lac. The lac of *Butea* is reddish.

The total inland trade in lac in India proper, carried by rail and river in 1888-89 was composed as follows :—

Stick lac,	..	200,000 maunds,	worth	36	lakhs	of rupees.
Shellac,	..	125,000 „	„	65	„	„ „

In India lac is used in the manufacture of bangles, lacquer ware, varnishes, and sealing wax ; in Europe for the preparation of spirit varnishes, cements, lithographic ink, and sealing wax, and for the stiffening of hats.

Section II.—Silk.

Perhaps no country in the world is so rich in indigenous silk-producing insects as India, the number of species exceeding thirty. They are divided by F. Moore into—

I.—The mulberry-feeding group, represented by the various domestic Bombyces and by the wild *Theophila*. *Theophila Huttoni* is abundant in the North-West Himalayas, but Mr. Cotes says : "It has not been found possible to rear the worms successfully in captivity, and the silk is not made use of commercially at present. The worm is bivoltine in Mussoorie." The name of the group is misleading, as several species feed on other Urticaceous plants : thus *T. religiosa*, the *jori* of Assam and *deo-mooga* of Cachar, lives on *Ficus bengalensis* and *religiosa*.

II.—The Altas and Eri group, comprising the genus *Attacus*. *A. Altas* is found in many parts of the empire feeding on a variety of trees. It is not cultivated, but its silk, when procurable, is highly prized. The eri silk, possessing little lustre and not capable of being reeled, but extremely durable when woven, is produced by *A. Ricini*, which is entirely domesticated.

III.—The Actias group.—*A. Selene* is found in many parts of India on *Pieris ovalifolia*, *Coriara nepalensis*, cherry, walnut, *Odina Wodier*, &c. Mr. Cotes says that no use is made of its silk.

IV.—The tusser and mooga group, comprising the large genus *Antheræa*. The two most important species, and indeed the most important of the wild silk-producing moths of India, are the *tusser* (*A. Mylitta*) and the *mooga* (*A. Assama*). The former is bivoltine, the latter multivoltine, the first and last crops being most productive as well as of the highest quality. Both are largely reared in the open air, the tusser chiefly in the Central Provinces and in Chhota Nagpur on various trees, the principal of which are *Terminalia tomentosa* and *Arjuna*, *Lagerstrœmia indica*, *Carissa Carandas*, and *Zizyphus Jujuba*, the mooga in Assam on *Machilus odoratissima*

and *Tetranthera monopetala.* The trees have to be pollarded both for convenience and to produce a good crop of leaves. 24 lbs. of mooga silk per acre, valued at Rs. 110 to 130, is a good out-turn. The expense of rearing is trifling. The cocoons of both the tusser and mooga worms can be reeled and yield a valuable silk, that of the former being remarkable for its strength and durability and consisting of tape-like, not the usually cylindrical, filaments.

V.—A MISCELLANEOUS GROUP, including *Rhodia Newera*, found in Sikkim and Nepal, and *Cricula trifenestrata*, or the mango silk-worm, distributed in most parts of the empire. The silk of the former is not used, while that of the latter cannot be reeled and is not of much value.

The Inland Trade Returns for 1888-89 for India proper show a trade in home-produced raw silk valued at nearly 2 crores of rupees. The trade in silk fabrics, independently of a large local consumption, reached the figure of 60 lakhs.

SECTION III.—HONEY, WAX, AND MANNA.

Honey and wax can, for the forester, be only natural products; but, thanks to the teeming numbers and extensive distribution of our wild honey-making bees, they are obtainable in very large quantities, especially where rocky scarps and large trees abound. The combs are often as much as 6 feet long and 3½ feet broad. The usual mode of collecting the honey is to smoke off the bees, the men covering themselves with blankets and carrying a torch at the end of a pole. This practice injures the honey; but there are some tribes which possess the secret of anointing their bodies with some substance, so that not a single bee will touch them. The honey is obtained by expression. The remains of the comb are then put into boiling water, the wax soon floating on the top, where it hardens on the water being cooled. In this state the wax is known as yellow or virgin wax. The best honey in India is made by a species of Trigona, which is a small stingless bee and builds its comb inside hollow trees.

Manna or honey-dew is the sweet substance excreted chiefly by some Aphidæ. In certain, especially dry, years, these insects breed in enormous numbers, so that every tree of the species on which they live becomes infested with hundreds of thousands of them. The total amount of sweet substance excreted is then so large, that the leaves and twigs become covered with a thick syrup, much of which also falls upon the ground. The species frequented by such insects are principally gregarious conifers and

only a few broad-leaved species, such as *Elæodendron glaucum* and sál.

Honey-dew is eagerly gathered, for home consumption, by the inhabitants of the Himalayas. The encrustation is washed off the leaves and twigs in hot water, which dissolves it at once. The syrup is then strained and boiled down to the consistence of honey, for which it may be easily mistaken by its appearance. A considerable proportion of the honey-dew crytallises at ordinary temperatures.

SECTION IV.—HIDES, HORNS, BONES, AND IVORY.

Every year thousands of cattle die inside our forests, the carcasses remaining unappropriated by the Hindu owners. Unless arrangements are made to secure the hides without delay, carrion-eating birds and quadrupeds soon destroy them and valuable raw material is thus lost. Excluding Burma, the inland trade during 1888-89 in raw hides amounted to 75 lakhs of rupees and in leather to 83 lakhs. These figures leave out all local consumption, which is worth many times more, since every village has its tanners and nearly every village its shoemaker. In the same year Calcutta alone exported to inland places 30 lakhs' worth of leather goods.

The horns of the dead cattle, especially if they are buffaloes, are also worth collecting. There are, at present, practically no workers in horns in India, but there is a large export trade in them to Europe (about 65,000 maunds, of an aggregate value of 9 lakhs of rupees), and the day cannot be far distant when combs and other articles will be extensively manufactured from horns in India itself, instead of the raw article being sent out of the country or allowed to perish in the forests and on the outskirts of towns and villages.

The so-called horns of deer contain no horny matter at all, but consist entirely of bone and really constitute an inferior kind of ivory. A small quantity of deer horns that have been shed can be collected in almost every forest and would command ready sale. As regards ivory, since the number of elephants is kept down by the kheddah operations, and elephants live to a great age, the annual find will always be insignificant and irregular.

Bones are used for buttons, handles of knives, &c., and are also ground into meal for manure. A large export trade to England in bone-meal has recently sprung up from Bombay and Kurrachee and along the routes leading to those ports. The total exports from the country amount to about 50,000 tons a year. The price of the meal in Bombay is Rs. 35 to 45 per maund. As yet the Indian

ryot is too prejudiced to use bone manure, but before long the prejudice will disappear, and then every scrap of bone lying in the forest will become marketable.

The best way to dispose of the products grouped under this head is to give out annual leases for their collection, but great care must be taken that the animals are not poisoned or shot by the lessees.

SECTION V.—HUNTING AND FISHING.

In all advanced countries a considerable income is derived by the owners of forests and streams from hunting (including snaring and trapping) and fishing; and, where dangerous animals abound, special arrangements are maintained by the State for their destruction. Two principal causes have hitherto militated in India against the introduction of laws to regulate hunting and fishing: (1) the great abundance of game and fish in comparison with the wants of the apathetic population, and (2) the unwillingness of an important section of the community to submit to restrictions in the matter of sport. An excellent beginning has, however, now been made in the Central Provinces and Madras, close seasons have been declared for certain descriptions of game in most provinces as far as the State forests are concerned, and numerous municipalities treat some kinds of dead game as contraband during the breeding season. Fire-conservancy has also operated in the preservation of game and fish by closing the conserved forests during nearly half the year, and thus affording game a safe retreat and protecting the higher reaches of rivers from molestation. Circumstances are thus ripe for extended imperial legislation, which cannot be undertaken too early, and which the Supreme Government have already under their earnest consideration.

In regulating hunting the following general points, amongst numerous others of a more special or local character, must be kept in view:—

(1). Separate rules must be made for animals dangerous to man and cattle. If such animals cannot be exterminated, their numbers must be kept down as low as possible; hence special facilities should be given for their destruction, and rules must be relaxed and large discretionary powers given to the superior local officials in the case of rogue elephants and man-eating *Felidæ* and *Canidæ*. Where dangerous animals abound, the District Magistrate or Divisional Forest Officer may surely be empowered to organize and conduct annual expeditions for their destruction, a reasonable budget grant being allowed for necessary expenses. Forest con-

servancy, by affording increased cover and protection and a larger supply of food, favour in a remarkable manner the multiplication of elephants and beasts of prey. The rewards offered for killing dangerous animals must be adjusted to the urgency of their destruction: a single tariff for an entire province and sometimes even an entire district is a mistake. Solitary wild boars not unfrequently become dangerous enough to require being specially marked down for destruction.

(2). All vegetable-feeding mammalia are harmful to field crops as well as to forest growth.* Pigs will break through almost any fence, and deer and antelope will clear most obstacles that can be put up to stop them. Limitation of their numbers is, therefore, in the interests of all. Their total annihilation would be a mistake, for by their presence the ravages of the large beasts of prey amongst men and live-stock are restricted, and they supply a large part of the population with meat, and provide an innocent and absorbing pastime, than which nothing better can be conceived for developing sense of locality, powers of observation, capacity for endurance, fertility of resource, self-control, and promptitude of judgment. Moreover, the right of hunting them may be sold for a sum of money large enough to more than cover the risks arising from their preservation. In the case of deer and antelope no hunting should be allowed during the rutting time, and the killing of females should be forbidden during the entire breeding season, which extends roughly from 1st July of one year to 1st March of the following year. After a careful study of the habits of the animals and the capacity of the forests to yield them food without suffering real harm, the number of full-grown males and females to be preserved in each forest should be fixed, all above this number being considered legitimate quarry.† If the actual numbers are under this minimum, no hunting should be permitted until its figure has been reached. In the case of forests bordered by extensive cultivation, the safety of the fields must also be considered in fixing the head of game to be maintained, but their ravages will usually be found confined to a very narrow belt of cultivation, and the owners of fields lying within this belt will in any case find their compensation in a lower assessment of land revenue. As

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* Elephants are under the protection of a special Act, and the Forest Department can only suggest their being caught when they have become numerous enough for a kheddah.

† This may sound unsportsmanlike, but our concern is with the good of the country—forestry first, sport afterwards.

regards pigs, they are so prolific that, in the present condition of the country their numbers can seldom be kept down without the help of one or more large battues a year, in which every neighbouring villager should be invited to join. The organisation of such battues will cost no money, as most people will be only too glad to get meat free and enjoy the pleasure of the sport, and every one will do his best to get rid of a pest that ravages his crops.

(3). The destruction of birds other than game and edible birds should be forbidden, and for these latter a close season should be observed, long enough to allow the young to be sufficiently grown to take care of themselves. The Central Provinces Government, acting on the advice of that accomplished sportsman and naturalist, Mr. R. Thompson, has adopted the following limits for the various game and edible birds :—

1.	Sand grouse, ...	... 1st October to 31st May.
2.	Pea-fowl, ...	... 1st March to 30th November.
3.	Jungle fowl, ...	... " " " "
4.	Spur-fowl, ...	... " " " "
5.	Partridge, grey and painted,	1st June to 30th November.
	" black,	... 1st January to 30th November.
6.	Quail, ...	... 1st May to 30th November.
7.	Bush-quail, ...	... " " " "
8.	Bustard-quail,...	... " " " "
9.	Bustard, ...	... " " " "
10.	Lik-florikan, ...	... " " " "
11.	Spurred goose,	... 1st June to 30th November.
12.	Goose-teal, ...	... " " " "
13.	Whistling teal,	... " " " "
14.	Grey duck, ...	.. " " " "
15.	Green pigeon,	... 1st February to 31st July.
16.	Blue rock-pigeon,	... 1st November to 30th June.
17.	Doves, ...	... 1st November to 31st May, but for *Turtur senegalensis*, 1st February to 31st July.

Most birds are the forester's friends, and should, therefore, be carefully protected by him.

(4). The practice of snaring of birds in the vicinity of large centres of population should be discouraged or even put down as much as possible.

(5). For the destruction of a proclaimed animal, such as a man-eating tiger, rogue elephant, &c., three lines of action offer themselves. Either the local officials may organize an expedition,

or a single individual or party may receive exclusive permission to hunt it, or numerous parties acting independently of each other may be allowed to pursue it. The first system is obviously the most likely to succeed and exposes the forest to the fewest risks. Failing it, the second system is to be preferred, but the forest officer must assure himself that the individual or party commands all the necessary resources for success.

(6). For the destruction of ordinary game, the right to hunt in a specified locality may be leased to a single party, or all may be allowed to come who obtain a permit to hunt. The country is at present not advanced enough for the general adoption of the former alternative, which is without doubt the one to strive for, as it fixes responsibility and the wealth and position of the single lessee are a guarantee of his good faith. In adopting the other alternative a reasonable fee should, whenever possible, be charged as the price of the permit. The amount of the fee should be regulated principally by the value of game in the locality, the accessibility of the forest, and the number of applicants. If it is desired to limit the number of applicants, high fees should be charged. The fee may be fixed for the whole year, or the year may be divided into periods, the scale of fees for the several periods being proportionate to the dangerous nature of the season for forest conservancy and the convenience of the time of the year for seeing and tracking game. The levy of the fees should be based on the number of "effective guns" with the party, *i.e.*, the number of persons carrying and using guns. The number of elephants used in hunting should also be taken into account, and a certain fee charged for each such elephant. All other things being the same, the success of a hunt will depend on the number of elephants used, and sportsmen possessing the means to employ elephants are *ipso facto* able to pay higher fees than other people. Moreover, elephants crush and break a good deal of the forest growth, besides grazing as they move along. On the other hand, sportsmen mounted on elephants have less temptation to fire the grass, and are more to be trusted than the majority of those who cannot afford the use of elephants. The fees should in any case be high enough to leave a reasonable surplus after paying for additional establishments required by the increased supervision necessary for controlling the hunting. Every large hunting party should be accompanied by a trustworthy official, whose special duty will be to look after the followers and prevent acts endangering the safety of the forest, particularly when the party is encamped inside the forest.

Fishing is very much more easily regulated than hunting. It involves but little, if any, risk to the forest, and is limited to definite lines, and may often even be restricted to certain lengths of the course of a stream or to pools and tanks. Hence the sole object to be sought in prescribing rules for fishing is the preservation of the fish, and to this end the poisoning or damming up of water should be absolutely prohibited and a minimum size of mesh should be fixed for fishing nets. A close season may also be prescribed for fishing generally in special spawning grounds or for particular kinds of fish everywhere. For purposes of revenue, the right of fishing may be leased or a certain fee may be levied per net or rod. In the rains, when the rivers are in flood, the water-courses that are at other seasons dry, become rapid torrents, and fish come up them in shoals and are easily clubbed. From people who thus club fish and from those who catch fish by torchlight from under stones and boulders it will always be difficult to collect revenue. The latter practice must, however, in most cases be forbidden.

CHAPTER IX.—MINERALS.

Numerous mineral products are obtained from forest areas. The principal of these are building stones, which may be either for cut-stone or for rubble (including boulder) masonry; flagging and paving stones; slates; metal for macadamised roads; gravel and sand; lime-stone for mortar and plaster; gypsum, kaolin and potter's clay; talc and mica; coloured clays for plastering and dyeing; peat and lignite; ores; and gold; and so on. These various materials may be obtained either (1) by quarrying, or (2) by cutting down or breaking up a hillside, or (3) by collecting off the surface of land producing or capable of producing forest, or (4) by gathering from stream beds. The second of these methods is an extremely destructive one, unless the portion of the hill to be cut away is judiciously chosen and is of limited extent, and the stones removed are not allowed to be rolled down the hillside. The danger is greatest in loose sandstone and metamorphic formations, especially when only particular strata are exploited, in which case the removal of these strata necessarily undermines those overlying them. Unless precautions are rigidly enforced, any kind of vegetation on the hillside will become impossible and the safety of the hillside itself will be threatened. The third method, which is very commonly resorted to in broken country of trap and sandstone formation, is always harmful. As the stones lie about everywhere, their collection and removal to central export depôts result in much damage to forest

growth of all ages. Quarrying into the earth is much less dangerous than the two methods just referred to; but unless regular metalled roads or tramways are made to the quarry, the constant going to and fro of heavily laden carts will do damage to a large extent of surrounding forest. The least dangerous of all the four methods is collection from the beds of streams; the materials being taken in small quantities from a great many points all along the course of the stream, there is never any dangerous concentration of traffic.

If kankar or any other limestone is used, burning it on the spot secures economy both of fuel and carriage. The kilns should be constructed only on open sites some distance from good forest growth. The most convenient mode of levying payment, when the utilization is on a large scale, is to lump up the price of the firewood and stone together and to charge a fixed rate for one burning, according to the capacity of the kiln. By this means the worry and labour of frequent measurements and of watching against unpaid removal, as well as all chance of disputes, are effectually avoided, and no premium is offered on careless or unskilful burning. In the dry shallow beds of streams issuing from the Himalayas, numerous pebbles and boulders of limestone are annually brought down by the floods during the heavy rains. They are collected without trouble, and yield excellent lime which is much in request. This limestone is best sold by leasing for a lump sum, for a whole year or season, definite lengths of the stream course, and then the price of the fuel should be separately recovered at so much a charge according to the capacity of the kiln.

The exploitation of ores will nearly always be effected on the same basis as that of limestone. Iron-smelting, on a small scale and according to most primitive methods, is carried on in many of our forests.

In several of our rivers washings of the sand yield a small quantity of gold. As it is impossible to check the quantity collected, each collector should be made to pay a certain fee per month or season, according to the richness of the sands.

Stones for building, paving and road-material, and other minerals are best sold by measurement, although exceptional cases may occur in which the levy of a fixed rent will be found preferable.

PART III.

MINOR FOREST INDUSTRIES.

THE only minor forest industries that will be dealt with in this Part are—

I.—Charcoal-burning.
II.—Manufacture of cutch and katha.
III.—Distillation of sandal-wood oil.
IV.—Preparation of turpentine products.
V.—Impregnation of timber with antiseptic substances.

Several petty industries have already been briefly described in Parts I. and II.; as, for instance, the manufacture of tar at page 147, Vol. XVI., the distillation of teak and deodar oil at page 17, and so on. In the course of a few years the number and extent of these minor forest industries in this country are certain to undergo an enormous expansion, requiring the employment of hundreds of thousands of the population.

CHAPTER I.—CHARCOAL-MAKING.

If wood is burnt with free access of air, there will be nothing left of it but a small quantity of ash varying, for most of our species, from ½ to 2 per cent. of its dry weight. If, on the other hand, air be entirely excluded and the wood subjected to a temperature of 300° to 350° C., a number of liquid and gaseous products will be given off, what remains behind being charcoal. Charcoal-making, or the carbonisation of wood, is thus only a process of destructive distillation. In this process all the moisture, most of the oxygen and hydrogen of the wood, and about half the carbon are expelled, so that the charcoal consists of the remaining carbon, oxygen and hydrogen, and all the ash elements, the carbon constituting about 90 per cent. of the whole. Actually the charcoal-burner uses wood with its bark on, the result being a somewhat larger proportion than 10 per cent. of elements other than carbon.

As just said, more than half the aggregate quantity of the combustible elements, *viz.*, carbon, oxygen, and hydrogen, is lost in carbonisation. But, on the other hand, the advantages gained are numerous and important. In the first place, the heating power of charcoal is very nearly twice that of the same weight of wood, being

just a little inferior to that of English coal and nearly equal to that of Indian coal. In the second place, charcoal is easier to light and maintain burning than wood, and gives out a very much more steady heat. In the third place, charcoal makes a clear, smokeless fire, and on this account is preferable, for metallurgical purposes, to coal in the production of the finer varieties of iron and steel. In the fourth place, it is always ready for immediate use, whereas wood has to be cut or split up to convenient sizes. In the fifth and last place, in addition to being so very much more effective and convenient a fuel, it is less than a quarter of the weight of the original wood and less than half the bulk, so that it can stand very much longer carriage (at least three times as long) than wood, and thus enables us to utilise the small produce of distant forests that would otherwise be quite unsaleable and have to be left behind in the forest to feed forest fires, favour the unchecked multiplication of destructive insects and fungi, and impose a forced limit on the improvement of the stock.

There are numerous methods of making charcoal, but they may all be reduced to three main systems, according to the care taken to exclude air. These three systems are (1) carbonisation in retorts and close ovens, (2) carbonisation in ordinary kilns, and (3) carbonisation in open pits.

Whichever method is adopted, it is necessary that all the wood in process of carbonisation should be converted into charcoal as nearly as possible simultaneously; otherwise those pieces which were carbonised first would become partially or wholly consumed, or would at any rate deteriorate under continued exposure to the intense heat, while the carbonisation of the remaining wood was being completed. Hence, woods of very different densities, as well as pieces of very different thicknesses, should never be mixed together. There is also another objection to carbonising woods of different densities together. The quality and, consequently, also the use to which the charcoal is put, depends to a great extent on the density of the wood; so that the different qualities of charcoal should be kept apart from the beginning, as it would be impossible to separate them afterwards. Very thick pieces must, in any case, be split up in order to hasten the carbonisation, and the thicker billets may also be split up so that they may be carbonised with thinner ones. The pieces to be carbonised should be dressed straight, in order that they may pack close together. Unsound wood should never be used, as it will yield no charcoal. Lastly, if the wood is to be carbonised in retorts or close furnaces, it should be as dry as possible in order to economise both fuel and time; and if it is to be

carbonised by any other method, which requires the admission of a certain considerable quantity of air to produce the necessary temperature, it should be just dry enough to develop that temperature without burning too rapidly and being consumed to no purpose. In the latter case, the quantity of moisture allowable will be in direct proportion to the dryness and high temperature of the air, the defective nature of the covering over the kiln, and exposure to winds.

SECTION I.—CARBONISATION IN RETORTS AND CLOSE OVENS.

In every method of carbonization in retorts or close ovens the double object is sought of obtaining the charcoal and of securing the products of distillation, thus allowing no portion of the wood to go to waste.

A convenient and general form of oven used in England consists of a cast-iron cylinder laid horizontally in masonry with a fireplace below. The wood is put in at one end, which is then closed with a well-fitting iron door that is carefully luted to render it completely gas-tight. For the first two or three hours the fire is kept low to dry the charge of wood. It is then driven hard until carbonization is complete; but if the operation is conducted too quickly, the yield of charcoal may be reduced by as much as 30 to 45 per cent. A charge of 100 stacked cubic feet of wood requires 12 to 13 hours to give the best results. During carbonization the following process takes place. First, the free moisture of the wood is driven off; then, as the temperature is raised and decomposition of the wood occurs, acetic acid and water are given off, followed by tar and volatile oils, and lastly by uncondensable gases, *viz.*, carbon monoxide and dioxide, and marsh and olefiant gases. The products of distillation escape through a pipe at the other end, whence they pass into the condenser. The condenser pipe gets rapidly clogged with tarry matters; it must therefore be composed of short straight lengths that may be speedily cleaned out. At the exit end of the condenser pipe there are two outlets, through the lower one of which pass out the condensed products, consisting of water, pyroligneous acid, ammonia, tar, naphtha, and various oils and resinous matter; through the upper the uncondensable gases above mentioned, which, instead of being allowed to pass off into the atmosphere and taint it, are conducted into the fireplace to feed the fire. In order to utilise to its fullest extent the heat of the fire, the products of combustion, with the heated air, are made to circulate in an enclosed space, between the oven and the floor of

a drying room above, before passing up the shaft of the chimney. In this drying room is stacked the wood to be carbonized afterwards. Any number of ovens may be set up side by side in the same building. The condensed products of the distillation are delivered into a tank, where the tar settles down to the bottom and is drawn off, while the supernatant liquid, after the lighter tarry and carbonaceous matters which rise to the top have been skimmed off, is pumped up into a reservoir containing a solution of lime or soda to form the acetates, from which the pure acetic acid of commerce may then, if required, be distilled after admixture with sulphuric or hydrochloric acid. When the run of liquid from the condenser ceases and the exit pipe from the cylinder becomes cool, it is known that the distillation, in other words, the carbonization, is complete. The fires are allowed to die down, the door is opened, and the charcoal raked out into a deep iron waggon with a close iron cover, which is luted down with clay to prevent the charcoal from taking fire in contact with air.

In some other works in England, instead of the cast-iron cylinders, they use more or less square ovens, into which the charge is introduced in sheet-iron waggons. The waggons are filled up to about 18 inches above the sides ; with the progress of carbonization the contents ultimately subside below the sides. In this method the charcoal is at once withdrawn in the waggons and thus runs no risk of breaking.

The disadvantages of the cast-iron cylinders are a liability to crack, and a larger consumption of fuel owing to the thickness of the plate. On the other hand, the wrought-iron ovens are apt to leak at the joints and doors, to warp with the heat, and to be more quickly corroded by the acid products of the distillation. The yield of charcoal in both kinds of apparatus slightly exceeds 25 per cent. of the weight of well-seasoned wood ; but this of course leaves out of account the fuel consumed below the cylinder to effect carbonization.

A form of apparatus much used in France consists of a cylindrical cast-iron retort, which, after being charged and closed, is hoisted into a close-fitting brick furnace or jacket with a fire-place at the bottom. A strong air-tight cover is put over the furnace. As soon as the distillation is finished, the retort is hauled out and a fresh one put in. In another very convenient form of apparatus, M. Kestner's pattern, the retort is fixed and built round with masonry. Both patterns are very simple and less costly than the two English forms described above, but their object is principally to obtain a good yield of pyroligneous acid.

Apparatus have also been invented for distilling sawdust. Owing to its finely divided state, sawdust cannot be distilled in the ordinary retorts, as it forms a dead mass and becomes carbonised only superficially. For this reason, the sawdust is fed into the retorts very gradually, and is constantly moved on, on an endless iron band, until it finally leaves the retort at the other end in a fully carbonised condition. The charcoal is comparatively useless, but it may be made up into patent fuel.

Very successful carbonization may be effected in ovens built entirely of brick masonry and ending in a narrow chimney. Such ovens may be made large enough to take up to 6,000 cubic feet of wood. The wood is carefully packed inside, several vertical flues, filled loosely with the smaller pieces, being formed, in order to secure a free through-draught and to distribute it uniformly. Just enough air is admitted through the sole of the furnace to carbonize the wood. The products of distillation pass out into convenient receptacles through openings at the sole of the furnace. The carbonization is complete when the smoke issuing from the chimney turns from black to a bluish white.

The great disadvantage attaching to all fixed works is that the wood to be carbonized has to be carried to them, often at prohibitive expense. Hence their general inapplicability, except when the products of distillation obtained serve to cover the increased expenditure.

To overcome this drawback various portable apparatus have been devised, two of which are described below. One of these, designed with the double purpose of effecting carbonization and securing the products of distillation, is M. Moreau's patent. It consists of a cast-iron furnace, having the shape of an octagonal prism and capable of containing about 400 stacked cubic feet of wood (roughly about 120 maunds). Tubes fixed at the top carry off the products of distillation, while ingeniously designed self-acting valves at the bottom allow of the wood inside being lighted, as well as regulate the entry of air to keep up the combustion, the valves completely closing of themselves when this becomes too active. The whole apparatus can be quickly taken to pieces, and transported and set up again with ease. The carbonization is completed in 30 hours, and the yield, by weight, of charcoal is said to reach 23 to 24 per cent.

Another apparatus, the invention of M. Dromart, consists of a beehive-shaped oven, capable of containing about 800 stacked cubic feet, and composed of plates of sheet-iron which fit closely together at the edges and are supported on a strong circular iron frame. This

oven, open at the bottom, is placed over a fire-place built up with brick or clay and provided with numerous holes through which the heat from below can enter it. Some of these holes are covered over with a sheet-iron plate to moderate the heat. The oven terminates in a chimney that can be closed or opened at pleasure. The wood is stacked within the oven through a side-door. When lurid vapours begin to issue from the chimney, an event that is not long in occurring, the carbonisation is complete. All that has then to be done is to close the chimney, put out the fire under the oven, and allow this latter to cool down. The apparatus is extremely portable, and the fire-place may be built up anywhere without skilled labour.

As contrivances merely for the manufacture of charcoal, neither of these two last-described or other similar apparatus are likely to come into general use, as they can never supersede the inexpensive wholesale methods of carbonization in ordinary kilns, which can, besides, take in pieces of any size without requiring them to be split up small. Those permitting of the utilization of the products of distillation must, however, at no distant date, enjoy a certain extended application in India in meeting the large demand that is sure to arise for acetic acid, wood spirits, ether, creosote, tar, &c.

SECTION II.—CARBONIZATION IN ORDINARY KILNS.

In every system of carbonization in ordinary kilns, the covering over the wood is a rough one (generally of leaves and earth), the wood in the kilns has to keep up its own combustion, and the emplacement of the kiln is not in any way built up.

There are numerous forms of such kilns, but only four of them, which are simple to build and manage, and are thoroughly practical and in very general use, will be described. They are (1) the paraboloidal over-ground kiln, (2) the paraboloidal pit-kiln, (3) the hill kiln, and (4) the prismatic kiln.

ARTICLE 1.—THE PARABOLOIDAL OVER-GROUND KILN.

The shape of the kiln, when it is ready to be fired, is very nearly a paraboloid of revolution, the formula for the contents of which figure is $\pi r^2 \times \frac{h}{2}$, or, expressed in terms of the circumference, C (which basal dimension alone can be measured), $\frac{C^2 h}{8\pi} = \frac{C^2 h}{25 \cdot 12}$. As the kiln is generally more acute than a paraboloid and has straighter sides, it is usual to diminish the contents given by the formula by 4 to 6 per cent.

1.—*Size of the kiln.*

The larger the kiln is, the less will be the relative quantity of covering material used, the more limited the space occupied, the fewer the men required, and the smaller the proportion of wood consumed in producing the heat necessary for carbonizing the remainder, and hence the lower will be the cost of carbonization. On the other hand, the larger kiln requires greater skill both to build up and to manage during the burning, and produces a harder charcoal. The largest kiln of the kind made in India seldom contains more than 1,500 stacked cubic feet of wood. A very convenient size for persons possessing little skill is one containing about 600 cubic feet.

(*To be continued*).

DATE FOR SUBMISSION OF ANNUAL REPORTS.

In your April—June issue I published a letter about the inconvenient period at which Divisional Officers have to write their Annual Reports. I have not seen any further remark on this except your editorial note, but wish to say, with reference to that note, that if Divisional Reports reached the Conservator by 1st August, the latter would still have three leisure months in which to get their own Reports out. I gathered from one Conservator that that time would suffice. Do let us make an effort to rectify this great nuisance, and if the Editor of "The Forester" would lend his powerful aid, probably the powers that be might be induced to move. It seems so simple.

Q.

NOTE ON THE GERMINATION OF THE KHARSHU ACORN.

In "Brandis' Forest Flora," page 480, it is stated that the seed of *Quercus semecarpifolia*, called *kharshu* by the Jaunsaris, ripens in August and germinates within a few days after it falls to the ground. This, however, is not the case in Jaunsar, and at the present time (26th July) almost all the acorns have fallen to the ground and are in different stages of germination. Some which dropped from the trees at the end of June or the beginning of the current month have nearly completed the process of germination, while others which fell to the ground only a few days ago have

not yet been able to develop the so-called taproot. Most of the acorns are one-seeded, although some of them certainly contain 2—4 seeds, as can be easily ascertained not only by breaking an acorn open, but also by the number of distinct taproot-like processes which sometimes burst forth from a single acorn.

What at first sight appears to be the taproot or an elongation of the radicle seems to me to be something more complex, and it would be very interesting to have its structure examined and explained by some botanist. As far as I can make it out, this pseudo-taproot appears to consist of (1) the nutrition tube, (2) the caulicle, and (3) the taproot proper.

(1). The nutrition tube (so termed by me for the sake of convenience) constitutes the upper portion of the pseudo-taproot, and extends from the base of the confer-ruminate cotyledons (still enclosed within the pericarp) to the invisible plumule which it completely encloses. Generally it is from one to four inches long, but the length varies according to the distance the whole pseudo-taproot has to travel in order to reach the soil, as will be explained further on. The upper portion of this structure imperceptibly passes into the two cotyledons, and it is possible, nay, probable, that it is nothing more than their petioles united together. Whatever its origin may be, and it is a matter for botanists to decide, it seems to me to serve some important purposes in the economy of plant-life, which will be presently noticed.

(2). The plumule, as said above, is enclosed inside the base of the nutrition tube, and is at first so small as hardly to be discernible with the naked eye; but it soon increases in size with the growth of the pseudo-taproot.

(3). The lower portion of the pseudo-taproot forms the taproot proper. It is from 3 to 6 inches long, and is enveloped in a sheath-like covering formed by the enlargement of the nutrition tube: it is, as a rule, thicker and longer than the portion occupied by the nutrition tube, and the caulicle has a fusiform shape, and is covered with small root fibres, which it begins to give off immediately after the process of germination is completed.

Such, in short, is the description, though a very imperfect one, of the structure generally regarded as the taproot of the kharshu seedling. I shall now say a few words about the peculiarities the seed of this tree shows in its mode of germination, as far as I have been able to observe them.

No sooner does the acorn fall to the ground than it begins to send out the complex organ just described, by the development of which the germ-plant itself is carried away from the seed. The

pseudo-taproot continues to elongate, often twisting spirally round itself, till its growing point reaches the soil. As this does not generally occur for many days after the seed has begun to germinate, and the root, before getting a proper lodgment, has often to toil through a mass of dead leaves, it is not unfrequent to find the false taproot grow to a great length before it begins to enter the ground. A great part of this length, however, is an elongation of the nutrition tube alone, the length of which, as I have stated before, varies with the distance the root has to travel in search for soil. If the soil is found close at hand, the nutrition tube is only a few inches long; if, on the contrary, the surface of the soil be remote from the position occupied by the seed, it will elongate considerably in order to reach this surface.

When once the growing point of the root has penetrated the soil to a sufficient depth, in which act it is greatly assisted by the gelatinous substance covering it, the nutrition tube ceases to elongate, the root begins to grow thicker and longer and to develop root-fibres on its surface, the portion of the nutrition tube occupied by the caulicle becomes ruptured and the enclosed plumule bursts into view. Even before any rupture occurs, the place of the enclosed plumule can be recognised by a conspicuous protuberance. In the earlier stages of germination, however, while the pseudo-taproot retains a uniform thickness throughout, it is rather difficult to detect the exact position of the plumule.

It is now easy to assign to the nutrition tube some of its functions. In the first place it serves to carry nourishment from the cotyledons to the taproot and to the plumule in all the stages of their growth, *i.e.*, from the time they are forced out of the closely cemented cotyledons to their full development into the seedling. The tube keeps up the connection between the cotyledons and the seedling until the latter is several months old, and sometimes the exhausted shrivelled-up remains of the cotyledons are found attached to one-year old seedlings by means of the dead tissue of what once formed the nutrition tube. In the second place, it serves to carry forward the future plant to a favourable place, however unfavourably the seed may be situated. And, lastly, it is possible that the formation of the nutrition tube, by removing the plumule and the radicle to a distance from the cotyledons, saves them from the attacks of insects, which frequent the food-gorged cotyledons.

When the plumule first makes its appearance, it is a very small thing, consisting merely of the terminal bud. It, however, begins soon to elongate itself, and when it is about an inch long, it is covered with a number of scale-leaves, each bearing a bud in its

axil. The stem continues to grow on till it is 2 to 3 inches in length, when the ensuing drought and frost bring it to a state of repose; but during at least the first year of its life it does not develop the true leaves, and is a slender, delicate-looking leafless shoot. The taproot, on the contrary, grows both in length and thickness in a marked manner; and while the stem is still only a delicate leafless organ, it is not unfrequent to find the root increased to more than 6 inches in length and a quarter of an inch in diameter. At the commencement of the following spring the seedlings begin again to push up, but it is not till the rains have set in, *i.e.*, till they are nearly a year old, that they develop their first leaves. A few exceptional cases, however, occur in which the first true leaves are formed during the same year in which the seedlings germinate. During the first three or four years of their life most of the seedlings die down annually, but are soon replaced by stronger and stronger shoots, which spring up, in some cases, from buds found in the axils of the scale-leaves, but generally from those which, at an early period of the plant's life, were developed at the root-collum. These collum buds in the kharshu oak are very conspicuous and vigorous, and I have now a two- or three-year old seedling before me, which, after dying down, has sent up again three strong shoots from the root-collum. While the aërial portion of the seedling thus dies down and renews itself annually, the root underground goes on elongating and strengthening itself by throwing out a number of rootlets until it is at once able to supply a large quantity of material to the portion above ground. As soon as this stage is reached, which the kharshu, I think, takes three to five years to attain, the stem begins to grow vigorously and to develop a larger number of leaves, and the seedling is then fully established.

In order to enable you to verify the results of my observations I am sending you a number of kharshu acorns in various stages of the process of germination, two or three yearlings, and some established seedlings.

The fact that the acorn, after the pseudo-taproot has sufficiently elongated itself, contains merely the two cotyledons firmly cemented together seems to me of great practical importance, and one which should not be lost sight of in raising the kharshu artificially. The practice at present is to cover up the seed with earth to a depth of one or more inches. This places the cotyledons in an unfavourable situation which nature never intended them to occupy, and in which they cannot get the amount of heat and oxygen required for the conversion of the nutritive substances contained

in them into materials that can be forwarded to the points where growth is to go on. The consequence is that they soon decay, and the germ-plant being thus deprived of its only source of food-supply perishes also. But if the seed is merely placed on the surface of the soil, without being covered with earth at all, the cotyledons get all they require of warmth and air, and are thus able to feed the germ-plant through the long nutrition tube, while the elongation of this last is carrying the germ-plant to a favourable place for its ultimate attachment and entry into the soil. I am of opinion that it is to a want of knowledge of the physiology of the germination of its acorn that so large a percentage of failures in the kharshu sowings of 1887 and 1889 in the Mohna Block are due.

DEOBAN :
26th July, 1890.

KESHAVANAND.

EDITOR'S NOTE —We have examined under the microscope the specimens sent by the author, whom we must heartily congratulate on his discovery of a most interesting peculiarity of germination that, strange to say, had never been noticed before by so many observant Foresters who have lived for years in the midst of kharshu forests. He is quite right in his conclusions as to the difference of nature and constitution between the upper and lower portions of what looks like the whole taproot. Above the level of the enclosed plumule the fibro-vascular bundles are arranged exactly as in the petioles of the foliage leaves of the same tree, and there can thus be no doubt that this portion consists simply of the united petioles of the cohering cotyledonary masses. Its tubular structure is easily explained. Before germination begins the plumule is situated at the base of, and between, the two joined cotyledons. When, therefore, the united petioles lengthen, the plumule, which is attached to their base, is carried down with the base while still enclosed between them; hence the continuous cavity beginning from the base itself of the cotyledons. The root nature of the portion below the level of the plumule is obvious from the presence of the axile bundle.

Thus in the kharshu we have a wonderful natural adaptation for ensuring successful germination under the doubly adverse condition of (i) an extremely short season of vegetation preceded by a severe winter and followed by a dry autumn, and (ii) of a thick covering of moss, *Strobilanthes*, &c., and dead leaves interposed between the germinating seed and the true soil. The elongation of the petioles of the cotyledons* carries the germ-plant to a point where the taproot can enter the soil, and the tube formed by the united petioles protects the enclosed plumule until the seedling has fixed itself in the ground. This accounts for kharshu seedlings being found even in the midst of the thickest growth of herbaceous Strobilanthes. Even when the plumule has burst through the petiolar tube, it develops no foliage leaves, but simply a short thin stem with scale leaves and buds at their axils, which buds, with rare exceptions, produce the first foliage of the seedling only at the beginning of the next season of vegetation, being dor-

* We have a similar case of elongation in the cotyledonary petioles of the sál, but there, as the cotyledons are always separate, the petioles are never united.

mant in the meantime; in other words, the developed plumule assumes at once a true *winter aspect*, a further natural adaptation for the protection of the young seedling where the short season of vegetation is abruptly followed by a dry autumn with chilly nights and a rigorous winter.

The author's remarks regarding the proper mode of sowing the acorn are fully justified by theoretical considerations. During the whole of the first season of vegetation and for the development of the foliage leaves at the commencement of the next season, the seedling is entirely dependent for its growth on the food stored up in the cotyledons, and unless the cotyledons are freely exposed to air and the warmth of the sun, the stored-up food cannot undergo the necessary changes to render it soluble and thus transportable to the growing seedling.

THE BHALKUA BANS (*BAMBUSA BALCOOA*) OF BENGAL.

DURING the late summer vacation, I passed the time very pleasantly and profitably in observing, among other things, the rate of growth of bamboo culms in a village in the district of Jessore in Bengal, and in inquiring into the singular traffic in bamboos carried on by a few villages round Jhinkargacha on the Kapatak (Kapotakshi) with traders in Patna and other towns of Behar.

For those who have not been in Bengal, I may, by way of preface, state that every village in Bengal may be looked upon as a small naturally-grown mixed forest, in which every stage of the struggle for existence, the effects of light and shade, of deficiency or excess of moisture, and other conditions affecting growth can be studied at leisure. Indeed, to a person stationed outside, the appearance of one of these villages is that of a dense mass of trees of various species, palmyra and cocoanut towering above all the rest, with here and there the gables of a two-storied building, should there be any in the village, peeping out curiously through the rich foliage, the low thatched mud huts, which form the bulk of dwelling houses, being entirely hidden under the mass of vegetation. Such woods are thus a truer epitome of a large natural forest than similar plantations elsewhere can be.

First, as to the rate of growth of bamboo shoots. The clump I selected for study was one of *Bambusa Balcooa* growing on a rich sandy loam under the dense canopy formed by two individuals of a gigantic tamarind tree, *Diospyros embryopteris*, and a few *Amoora Rohituka*, while a thick undergrowth of *Clerodendron* and other shrubs surrounded it on all sides.

As my stay was not long enough to admit of my making measurements at every successive stage of growth on one and the same

culm, I had to experiment on several culms representing the several stages of growth up to a height of 26½ feet. I could not go beyond this height, for the simple reason that no shoot had attained this height before my departure.

The measurements are tabulated below :—

Days	*Daily amount of elongation in inches of shoots.*				Remarks.
	Up to 6 in. high.	From 6 in. to 3 feet high.	From 3 feet to 10 feet high.	From 10 feet to 26½ feet high.	
20th June, ...	0·15	0·50	1·80	4·40	Day.
		1·05	4·25	8 50	Night.
21st „ ...	0·20	0·65	2·00	4 90	Day.
		1·15	5·00	9·80	Night.
22nd „ ...	0·32	0·95	3·25	6 50	Day.
		1·25	5 10	9·80	Night.
23rd „ ...	0·45	1·10	4 00	7 20	Day.
		1·30	5·50	10·20	Night.
24th „ ...	0 60	1·25	4·50	8·00	Day.
		1·50	5 60	11·00	Night.
25th „ ...	0·78	1·00	3·30	6·70	Day
		1 80	6 30	12 00	Night.
26th „ ...	0 95	1·10	3·50	7·50	Day.
		2·15	7 00	13 50	Night.
27th „ ...	1·20	1·25	3·75	8 50	Day.
		2·50	7 20	14 50	Night.
28th „ ..	1·35	1·35	4·10	10·00	Day.
		2 85	7 75	16 20	Night.
29th „ ..	...	1·60	...	11·80	Day.
		4 00	...	18·00	Night.
	6″·00	30″·30 =2·525 ft.	83″·90 say 84″=7′	199″·00 =16·58 ft	

Rainy and cloudy days.

The preceding figures corroborate in a very striking manner the important physiological fact that more elongation takes place at night than during the day, and that on rainy and cloudy days, when sunlight is least effective, the difference between day and night increments is least.

Now as regards the next subject of this short paper. In the group of villages collectively known as Gadkhali and in a few others near Jhinkargacha, a certain class of the inhabitants have from time immemorial been engaged in the singular occupation of bending young bamboo shoots, while still in the clump, into the

form of a shallow U in the middle. The bending is effected, as the tender shoot grows, by means of ropes attached at various points and secured to old unbent shoots of the same clump, the ropes being tightened or loosened from time to time, as the necessary degree of curvature at each point requires. No little skill is required to give the proper curvature without breaking the shoot. The shoot is headed down at the end of the first year at a height of about 25 feet from the ground.

When the bent culms are three years old, they are ready to be cut. The villagers themselves do not cut the bamboos, but sell them standing to the traders, who come nearly every winter from Behar to cut and take them away.

It will now be asked why the bamboos are so bent and what purpose they serve? In answer to my questions I was told that in Behar (and probably also in the western districts of Bengal proper) no marriage can take place without the bride and bridegroom being carried about, on one of the days over which the ceremony extends, publicly in the streets in a special open palanquin (dandy or tonjon). The body of the palanquin is boat-shaped and contains two seats at opposite ends facing one another, and it fits into the U of the bamboo, the more or less straight end portions (6 to 8 feet in length) being supported on the shoulders of the bearers. Each seat is wide enough to accommodate at least two persons. In the palanquin the bamboo is either fantastically painted or carved or otherwise decorated.

Some years ago such bamboos used to fetch in the clump as much as Rs. 60 and even more a score. The trade is not so brisk as it used to be, and the price per score has fallen as low as Rs. 20 to 25. The unbent shoots nevertheless still command a lower price, about Rs. 20 the score.

The bamboos are taken to Behar in rafts lashed on each side of a boat. The course taken is down the Kapatak and some other streams into the Ganges, thence up the Ganges to destination, an average distance of about 600 miles following the curves and bends of the rivers. They have never yet been sent by rail, probably because they are too long for ordinary wagons.

In spite of the long transit, with the profits of the importer and the palanquin-maker added on, their ultimate selling price must, notwithstanding the present low rates at the places of production, be still very high.

FOREST SCHOOL:
21*st July*, 1890.

UPENDRANATH KANJILAL.

A NOTE ON FOREST MANAGEMENT IN TINNEVELLY.

Coppice Coupes for Fuel, &c.

The Tinnevelly District is in the extreme south of India, and its rainfall ranges from about 20 inches in Tuticorin to about 200 inches on the water-parting, which is the boundary between it and Travancore, elevation averaging from 3,500 to 7,000 feet.

Up to the last three years it has, in common with other Forest Divisions in Madras, employed the so-called Thanadar (*Rawanna* in the North-West Provinces) system for the issue of permits for small timber, fuel, bamboos, charcoal, grass, and other produce.

Within the last two years, however, this system has almost entirely been done away with; and as the district is the only one in the Presidency which has attempted, what I hope will be evident, is a great advance in every way on the promiscuous fellings which obtained under the Thanadar system, I am justified, I think, in giving a brief résumé of the method now in practice.

To begin with, I must state that everywhere where we have opened coupes the forest is more or less scrub, with, in places, very poor growth of teak and vengai (*Pterocarpus Marsupium*), reminding me very much indeed of the Beribara coppice in Saharanpur, the component species, with the exception of the two above mentioned, being almost identical. The rainfall is probably on an average 50 inches. The soil is poor and gravelly with outcrop of gneiss and granite. But to counterbalance this poor growth, the demand for charcoal, fuel, even twigs and leaves, and small timber, is heavy and sustained, very little being left on the ground in an exploited coupe.

To begin with, and to make myself better understood, I am afraid I must give an outline of the system as it existed and now exists in all other districts. It differs from what is very much the same thing in Northern India, at any rate in the North-West Provinces, in having not only a Thanadar but also a Permit Gumashta, the duty of the latter being to issue tickets, and of the former to check the same at some spot where permit-holders must come to from the forest (this being obligatory under our timber transit rules), this division of labour being intended as a check upon each. The drawbacks of this system are manifold, chief among which are :—

(i). The promiscuous character of the fellings, the permit-holders being practically allowed to cut anywhere they please throughout the forest. It is true a cer-

tain locality for obtaining the produce is usually entered in the permit, but where hundreds of people daily go into the forests from different directions, it is of course impossible for the single Forest Guard in charge of thousands of acres to superintend the fellings, even if he has the wish to do so.

(ii). Difficulty of check by Forest Guards in our present short-handed condition, many Forest Guards having as many as three thanas in their beats, which comprise from 10 to 20 square miles and even more.

(iii). The great chance there is of fire occurring and the difficulty of detection, the ticket-holders being scattered over the whole forest more or less.

(iv). The impossibility of getting trees cut flush with the ground, in which case only they would furnish the best coppice-shoots.

(v). In consequence of many of the trees being cut in a leaf-canopy more or less complete, the impossibility of these coppice-shoots ever making good poles or even growing at all, as coppice-shoots notoriously demand more light than seedlings, at least in the first years of their existence.

(vi). As a consequence of (ii) the chances of illicit removals.

(vii). The cuttings not being confined to one spot, the possibility of their being done on steep hillsides which want all the growth they can bear for protection from erosion.

(viii). The great waste of wood caused by the permit-holder often cutting down a whole tree or several trees and only taking the particular portion of each which may be suitable for his particular purpose, leaving the remainder to rot or furnish food for the next forest fire, which, by the way, is often caused by these very permit-holders in order to make the forest more easy of circulation.

The above are really only a few of the most important of the multitudinous reasons which might be given. To do away with this system, favourable areas have been chosen—I mean places easy of access and affording convenient transport, which are as much as possible sheltered valleys and level ground where reproduction promises to be good. Through these areas base lines about 6 feet broad have been run, extending in some cases for six miles, and from these base lines other lines at right-angles have

been cleared, thus forming rectangular coupes of easily ascertainable areas.

These areas, generally 60 to 100 acres, have been put up to auction, and have realized from Rs. 5 to Rs. 45 per acre, depending a good deal on whether teak and vengai have been found in them or not. I have already stated that both these species are of the most inferior growth, never exceeding at the outside one foot in diameter, and for the most part twisted, heart-shaken, and distorted; but even these are eagerly sought after and converted into spokes, felloes, and poles. The system is that of coppice with standards, 15 or 20 standards of the best and straighest-grown trees being left for possible timber, or at any rate as seed-bearers. Binding contracts are drawn up with all purchasers that all trees and undergrowth must be cut flush with the ground, and the coupe perfectly cleared in a given number of months. The contractor is also held responsible for fires and illicit removals, and so far we have had no trouble in getting our work well done.

The standards are marked with tar, and hammer-marked at the base by the Forest Guards, and the rotation roughly laid down is 20 years. This number of years will probably be sufficient, as most of the forest is incapable of producing large timber, and the requirements are chiefly charcoal and fuel and small wood for house-building and agricultural instruments. The coupe rides are regularly cleared by guards and fire patrols and demarcated with stones, showing the year in which the coupe was felled, and a book is kept in the Range office showing the amount for which each coupe was sold. In some coupes it has been found possible to fell linear sample areas previous to sale, and then by stacking and weighing to determine the approximate yield. This operation is doubtless expensive, but will be eventually carried out in every coupe.

With this system we gain the following signal advantages :—

(i). Complete abolition of Thanadars and Permit Officers, resulting in a saving equal to about 20 per cent. revenue.

(ii). Fellings confined to one spot.

(iii). Hence easy check.

(iv). Less likelihood of fires occurring, as the purchasers are held responsible for keeping out fire, and, in case of occurrence, for keeping it within the limits of the coupe, the coupe rides serving as excellent bases from which to counter-fire.

(v). Improved re-growth, the original stock having been all properly coppiced.

(vi). Sufficiency of light let in both for reproduction from stools and seed, which is especially necessary in the cases of vengai and teak.

(vii). Perfect rest given to the parts not worked.

(viii). The greater care with which artificial reproduction by dibbling in seed in blanks can be carried out and results noted.

(ix). The difficulty of illicit removals, for not only is the purchaser bound to prevent the same by the Forest Act, but he is liable to forfeiture of his deposit, generally 25 per cent. of the total amount bid, if any is detected which he has not reported. All removals from the coupe are bound to be covered by a manuscript pass issued by the purchaser of the coupe, whose signature or that of his agent is registered in the Range office.

(x). Forest Guards and other subordinates given much more time for inspection of their charges and for the regular working of the more valuable high forest where selection fellings are being carried out. Moreover, if any illicit fellings are, by the connivance of forest subordinates, allowed to take place, the Forest Guard and contractor can at once be held responsible for the same, since they have not got, as at present, the excuse that the fellings were done by permit-holders.

(xi). Immunity from grazing, as all coupes are at once notified as closed to grazing in the District Gazette.

All we really want now is working plans to develop the scheme more thoroughly. These coupes are made at intervals of from 5 to 8 miles throughout the district, and are hence easily accessible to all villages.

J. G. F.-M.

FRUCTIFICATION OF THE KHARSHU OAK,

(*Quercus semecarpifolia*).

On pages 318-19, Vol. XIII. of the "Indian Forester," there is an admirable note by Mr. Hearle on the kharshu oak (*Quercus semecarpifolia*) of the North-West Himalayas, and the remarks he makes therein regarding its mode of fructification are specially valuable. During the last two or three years I have had the good fortune to watch the behaviour of this tree in its real home, and, as the subject may interest some of your readers, I venture to send you some of the facts noticed by me.

Some Foresters regard this oak as deciduous, while others main-

tain that it is never leafless at any time of the year. What I have observed in the Dooban forests leads me to the conclusion that, although in a large proportion of trees the old leaves persist for some time after the new ones have made their appearance, there are always some trees which are certainly leafless for one or two weeks during the spring. This departure from the evergreen type, at least in this part of the Himalayas, seems to be dependent on the influence exercised by the nature of the soil and rock and by the aspect, gradient, and climatic variations. On deep and rich soil, on westerly and easterly aspects, on slopes with gentle gradients, as well as in sheltered ravines the tree is, as a rule, evergreen; whereas on rocky ground with very little or no soil on it, on the dry and steep, more or less southerly slopes and on exposed aspects, it is not uncommon to find a large number of trees quite leafless for a few weeks in April and May. The effects of the late long drought, which lasted from September, 1889 to April, 1890, were clearly noticeable, in that a larger number of trees were found leafless during the spring of the present year than in any of the preceding three years.

The new leaves, as a rule, come out at the beginning of May, and this is also the time for the male catkins to appear. The female flowers, however, show no sign of their presence till the middle of June following, and at this time they are so small that without a careful search they are scarcely distinguishable from the bud scales among which they lie hidden. They are found on short spikes, which spring up from the axils of leaves at the end of the current year's shoots, and generally the spikes are placed in close proximity to the terminal buds, though in some cases they occupy the axil of the second or the third leaf counting downwards from the terminal bud. It is important to bear in mind this position of the female flowers at the end of the shoots of the year, for it will be shown lower down how it may account for the long period that intervenes between their first appearance and the ripening of the acorns.

Simultaneously with the appearance of the female flowers the male catkins begin to shed their pollen, and an examination of one of the former at this time will show a number of pollen grains adhering to its stigmas. This leaves no doubt as to the fact of the female flowers of one year being fertilised by pollen from male catkins of the same year, and the supposition that their fertilisation is effected only after a lapse of 12 months by pollen from male flowers of the following year may, therefore, be dismissed as untenable. The process of shedding the pollen is completed by the end of June, and there is reason to believe that before the end of next

July all the female flowers are fertilised. It is, however, possible that some months elapse from the time the pollen-grains reach the styles to the time the pollen-tubes come in contact with the ovules, but this is a matter which can only be ascertained by means of a microscope, and which I am not therefore in a position to determine.

At the end of July, when the process of fertilisation is apparently quite completed. the female flowers are only about $\frac{1}{16}$th of an inch in diameter, and from this time to April of the following year the increase in their size is so slight as scarcely to be appreciable. On comparing two sets of female flowers from the same tree—one taken at the beginning of August, 1888, and the other at the beginning of March, 1889—hardly any difference could be found between the size of the flowers composing them. This retardation in growth is not confined to the small acorns alone, but affects the other growing parts of the tree as well. Thus the spring shoots from the beginning of August to the end of the following March make next to no addition to their length, and the terminal buds during all this time also lie in a dormant state. As soon, however, as the new leaves begin to appear at the end of April, and long before the current year's male flowers are fully developed, the hitherto tiny acorns commence to grow rapidly—a fact proving conclusively that they must have been fertilised during the same year in which they were produced—and at the beginning of July, when they begin to ripen and are ready to fall, many of them are already more than an inch in diameter. At this time may also be seen the new female flowers, produced during the current year, occupying the axils of leaves at the end of the newly-formed shoots. Though now nearly a month old, they are still very small, and can with difficulty be distinguished from the bud scales which hide them. It is, therefore, certain that thirteen months intervene between the production of the female flowers and the ripening of the acorns.

This peculiar behaviour of the kharshu seems to me to be due directly to the short duration of the period of vegetative activity in these regions of the Himalayas. At the high elevations (8,000 to 10,000 feet) where this tree grows, this period is very short, and appears, in fact, to be limited to the interval elapsing between the development of the buds into leaves in April and the ripening of the previous year's acorns in July. By the beginning of August the shoots of the year have attained their full size, and thenceforth, if any growth takes place, it is insignificant. Consequently the female flowers, situated at their extremities, are unable to develop into acorns until the commencement of the following spring, when the shoots bearing them again become active, and the little acorns

are for the first time in a position to make the necessary progress towards maturity.

DEOBAN,
26*th July*, 1890. } KESHAVANAND.

THE PROSPECTS OF FORESTRY IN VICTORIA.

I FORWARD herewith a cutting from a Melbourne paper criticising the policy proposed by the Provincial Conservator in his last Annual Report, which may be of interest to your readers. Mr. Perrin would appear to have a somewhat hard task before him, as it seems that the forests in his charge are frequented by "saw-millers," who are not restrained by the imposition of a royalty from using or misusing the State timber. The arguments against a State Department obtaining the highest price for its outturn are that such an arrangement would raise the price of timber in the colony and encourage imports; whilst the community only wish their Forest Department to make revenue sufficient to provide for the pay of the protective establishment. Quite a touching picture is presented of the State distributing gold, coals, and trees to promote the general prosperity. A more enlightened critic would perhaps wish that the general public and not only those directly interested in forests, such as traders, saw-millers, and users of timber, should profit by proper protection and management of the State forests, and agree that this can only be done when general taxation is lightened by obtaining from the forest the highest revenue possible without infringing vested interests or encouraging the much-dreaded competition from neighbouring colonies. It is interesting to note that with very little outlay a School of Forestry can be established to provide well-trained Foresters, intimately acquainted with their craft and full of local knowledge. The means of procuring these desirable results cheaply should have world-wide publicity, so that other nations may imitate and profit. The restriction of unlimited grazing and the temporary closure of over-cut areas are favourably commented on, provided the saw-miller is not vexed. Mr. Perrin will doubtless congratulate himself when he reads that enthusiasm in forest conservation is pardonable, and he may, I think, be forgiven if he wished his critic a little more of that "ardour and creditable intelligence" which, "so far as can be seen," the Conservator possesses.

OBSERVER.

"Were it possible to express in figures the capital value of the forests of Victoria thirty years ago and their capital value to-day, a clear idea might be obtained of the loss caused by the reckless and wasteful felling

of trees which has been permitted. As it is, we may only indulge in conjecture, and imagine the extent of the loss. That there has been great sacrifice in the past is, however, beyond doubt, and it justifies the efforts now being made to place our forestry system on a sound basis. The ideal and the practical are really indivisible so far as forestry is concerned, for not only is it good for us to conserve and expand our resources, so that our capital may increase, but it is possible to do so. Nature has made the soil produce trees of great value, and so abundantly that it should be easy to overtake in any one year the consumption of that year. The management of the areas specially devoted to timber-growing ought, therefore, to be on such lines as will permit of all demands being supplied, and at the same time provide for recuperation to enable the necessities of the future to be served without any difficulty. If this policy be observed we shall soon forget the follies of the past, and shall applaud the wisdom which guided the Government in making a change in administration. So far as can be seen, Mr. G. S. Perrin, the Conservator of Forests, seems to be bringing to the performance of his duties the ardour of the enthusiast and creditable intelligence. His critics are inclined to believe that his enthusiasm is not tempered, as it should be, with judgment, but that remains to be proved. Enthusiasm in the cause of forest conservation may well be pardoned. It may lead to mistakes, but no mistake should be of so serious a character as not to be capable of being easily remedied. What Mr. Perrin should feel is that, as his reforms must touch vested interests more or less severely, it is better to proceed slowly than to cause unnecessary loss to the individuals directly affected. He may, by adopting this course, postpone the completion of his work, but will at the same time ensure that the advantage he is seeking will be the more lasting because achieved without undue friction.

"In the report lately presented to the Minister of Lands, Mr. Perrin covers the time which has elapsed since he assumed his present position, and not only brings into relief the bad effect of the unscientific manner in which the forests have been treated, but directs attention to improvements deemed necessary. Everyone will agree with him in his condemnation of the administration of the past, which was worse than useless. But, while approving of most of his proposals, it is necessary to say that his scheme for obtaining a royalty on all timber cut will require much fuller consideration than it appears to have received. In principle, no doubt, it may be right to make all saw-millers pay a prescribed price for each tree felled, but there are some practical considerations which have to be taken into account. The State does not wish to make a direct profit out of its timber. It is willing to dispose of trees as it disposes of coal or gold—in such a manner as to promote general prosperity. The only reasonable stipulation should be that there must be a sufficient revenue from licenses to enable such a staff of inspectors and rangers to be

maintained as is necessary to protect the forests and prevent spoliation. So long as the department pays expenses, the community will be satisfied. But the imposition of a royalty would not only be unnecessary for purposes of conservation, but would directly tend to increase the price of timber. The saw-miller would charge the royalty to the timber merchant, the timber merchant to the builder, and the builder to the house-owner. Besides, if the market is disturbed in this way, there will certainly be a stronger demand for timber from other colonies than now exists, and our saw-millers will claim additional protection. The advantage gained by the State on the one hand would thus be nullified on the other. These considerations cannot be disregarded. They are weighty, and, so far as can now be seen, are likely to prevent the "royalty" system being introduced. Still, it is impossible to find fault with the Conservator for making the suggestion. All things being equal, it would be a good thing for the State to sell its timber at the highest price obtainable; but all things are not equal, and the scheme appears to be impracticable.

"There are several other proposals in the report in which it is a pleasure to concur. Mr. Perrin shows his enthusiasm by suggesting that a School of Forestry should be established in connection with the agricultural colleges, so that in time the colony may command the services of competent, well-trained Foresters, intimately acquainted with the principles of their craft, and particularly informed of the best means of applying those principles to Australian conditions. It will be admitted that we cannot obtain men fully equipped with knowledge suitable to our requirements from Continental schools, and therefore it is desirable that they should be trained locally. As the proposition in this respect will involve very little outlay, it is to be hoped that the Government will carry it into effect. Mr. Perrin urges that the department should be given full control of all State forests, not merely to deal with saw-millers and splitters, but to regulate their use for grazing purposes. It is possible to allow them to be so used with advantage, but it is necessary that the Rangers should have power to prevent cattle roaming at large and destroying shoots and saplings. The damage done by indiscriminate grazing must be considerable. Mr. Perrin is also right in his desire to prevent the complete denudation of the red gum forests on the Murray, and he will, no doubt, be careful to carry his proposals into effect without harassing the saw-millers operating in that neighbourhood. It seems to be necessary, in his opinion, to close some of the areas for a number of years, to enable nature to make good the ravages of man. If the necessity is as great as he represents, there should be no hesitation in following his advice. It is so obviously in the interests of the saw-millers that this prudent course should be adopted, that we cannot understand how any objections could be urged against it. It is for the Government to say whether or not this valuable timber is to be preserved."

II. TRAVELS.

THE FORESTS OF THE UNITED STATES.

(Continued from page 165, Vol. XVI).

II.—THE INFLUENCE OF HUMAN ACTIVITY ON THE NATURE AND CONSTITUTION OF THE FORESTS AND ON THE SOIL AND CLIMATE.

WHEN the first Europeans landed upon the shores of the New World, there lay stretched out before them an expanse of virgin forest unique in its extent, in the number of its species, and in the age and size of its trees. No slope was too steep, no soil too poor or too water-logged for producing a rich forest vegetation. Trees, the trunks of which rose up to heaven like towers, were clothed every autumn with a blaze of scarlet and crimson foliage. In the intervals between their massive trunks were crowded together smaller trees of various species, while in the rich vegetable mould formed by the decay of by-gone generations of trees and hidden from the eye by mosses or by an exuberant growth of herbs and shrubs, seedlings and saplings, the prototypes of the coming generation of trees, threw out their roots in every direction and struggled for life securely sheltered from excessive heat and excessive cold. Mineral matters, by themselves inert, but now dissolved and converted into plant-food by the powerful chemical action of the decaying vegetation, were ever streaming up from the soil into the trees to return thence, not alone but combined with organic substances, back into the soil, which thus grew richer every year. What wonder then if the new comers were struck by the marvellous fertility of the soil, surpassing all previous experience, and if they deemed such soil quite inexhaustible? They did not know that once the forest was removed, the fertility of the soil would diminish more rapidly than it had increased under the cover of that forest. Now, it is easy to see in the enlightened 19th century that a single field crop, whatever it be, removes from the soil more plant-food than the unassisted chemical processes going on within the soil can make good in a single year, so that from the moment the forest is cut and an agricultural crop substituted the soil be-

gins to deteriorate and goes on from bad to worse unless an artificial fertiliser is applied.

It is the opinion of most people that if we cut down forest and at once re-stock the land or let nature sow it, no deterioration of the soil will ensue. This may be true in the case of the very best soils, and if our methods of regeneration imitate more or less closely those pursued by nature in a primeval forest. In the case of ordinary soils, and particularly in that of poor ones, deterioration must follow, since artificial manuring is obviously not to be thought of. I myself believe that it will probably be found to be a general rule that whether the land is kept under forest or is given up to agriculture, the immediate result of such action is to cause a diminution of fertility. Agriculture may bring about this result quicker than forest exploitation, but the end will be the same in either case. The necessary outcome of such deterioration will be the gradual falling off in the vegetation of those species which make the largest demands upon the soil. Such loss of vigour will be manifest in a steady diminution of the height attainable by those species, for we know that the richer the soil is, the taller will be the forest, and conversely that, other factors of growth being the same, the height of the forest is a certain measure of the fertility of the soil. Hence the cutting down of the primeval forest and the consequent deterioration of the soil and weakening of the more exacting species must lead to those species being gradually driven out in the struggle for existence by others which are satisfied with a poorer soil. Thus the walnuts, the hickories, and the oaks must, if unassisted, disappear before the birches, the poplars, and the pines; the forests of the white and red pines round the great lakes will be replaced by an inferior growth of the black or spruce pine; the precious forests of the southern pine, the finest pine in the world, must be completely invaded by the less valuable old-field pine or the slash pine, or by shrubby oaks and the short-leaved pine.

Europe and Asia have already seen these changes of growth consequent on the spoliation and destruction of primeval forests, and North America will not be long before it goes through the same experience, which will, however, be on a far more colossal scale. The laws of Nature and their reaction upon the action of man are everywhere and at all times the same. In Europe and Eastern Asia, the original hardwood trees have at many points been displaced by pines, birches, the spruce, and tall grasses, and there are now large tracts of light sandy soil so utterly exhausted by the action of the woodcutter that they can with difficulty bear a stunted

growth of pines of little value to the owner and of no value at all from a climatic point of view, and which have constantly to struggle for bare life against the weather, against insects, and against fungi. Already in the United States, in the South and North, we have extensive stretches of such soil, mostly covered with pines, which demand the most unremitting care to preserve them in a useful condition. If the forests of the southern pine-belt are allowed to be annually ravaged by fire fed by the fallen needles and the present thin growth of tender grasses, without taking into account the wasteful methods of orcharding or cutting down the pines and the clearing of the tree-growth from a soil that could scarcely bear a few consecutive crops of agricultural plants, we need no great scientific acumen to foresee with exactness the changes that will occur in the soil and climate of that poor sandy region. The tender valuable grasses, which under the protection of the light foliage of the pine now protects the soil of the virgin forest, will disappear with their nurses, and either give place to hard useless grasses capable of standing extremes of heat and cold, or leave no trace of vegetation behind them in the desert waste. Those wide belts of white, sterile moving sands which border both sides of the railways of the Gulf States show what the poorer tracts of the country will come to, if the Southern farmers do not give up their pernicious habit of setting fire to thousands of square miles every year.

Besides the slow but steady changes indicated above, others are to be noticed in certain places displaying the immediate revolt of ill-used, usually long-suffering Nature against the unregulated action of man, *viz.*, a sudden change of flora. In Wisconsin, Michigan, and Minnesota all slight hollows and depressions within the hard-wood region are filled with spruce, balsam fir, larch, or white cedar (*Arbor vitæ*). Under the dense shade of these trees the soil is covered with a thick matting of moss, which sucks up like a sponge all the water that would otherwise lie on the surface, and which grows at the top as the lower portions die away and decay; so that with the débris from the trees above a thick water-gorged substratum is formed, in which the roots of the trees spread out and luxuriate. Remove these trees, and no new growth of the same species can spring up again; the mosses, exposed to sun and wind, dry up and perish, a stagnant pool of water collects, and either worthless shrubby alders* or light-loving, coarse, hard grasses

* The Atlantic forests possess no large valuable alders like the American Pacific and the Japanese and European forests.

(species of *Carex* and *Arundineæ*) take the place of the vanished tree-forest. Numerous spots, on which, within the memory of many living settlers, stood noble cedar and larch forest, are now already unhealthy impassable swamps. To restore the forest and render the air once more salubrious is now an almost utter impossibility.

The consequences following the deforestation of mountain slopes are too well known. The pelting rain washes down all the finest, and, therefore, most precious particles of the soil, leaving behind only gravel and stones and boulders, and reducing the bare mountain side to a condition of complete sterility, unless grasses and shrubs are in the meantime allowed to grow and overrun it and stop further deterioration.

I may be permitted here to quote an instance showing how quickly nature retaliates when her laws have been violated. Here in Japan even the mountainous districts contain a comparatively large population, and the forests yield considerable quantities of chestnuts, horse chestnuts, mushrooms, ferns, tender leaves of trees, &c., which constitute to a very great extent the food of the people in addition to the rice that has to be brought up from the lower country. Many of the slopes, even those whose gradients run as high as 45°, are denuded of their forest covering, and are in the very first year sown with Indian corn, various millets, cucumber, small beet, the egg-plant, and, to a slight extent, wheat. Heavy rain, which is common enough, washes down the rich brown and black particles of the soil, furrowing the mountain side and forming in the valleys below small torrents, which sometimes expand into a huge mass of rushing liquid mud that sweeps away before it men, cattle, houses, bridges, and the unreaped harvest.

There appears to be, between Eastern America and the eastern part of the old world, not only a striking analogy in regard to the forest flora, but also a marvellous coincidence in regard to meteorological phenomena. Thus in the summer of 1889 the people of Japan were filled with horror and dismay at the inundations which destroyed thousands of human lives and did damage to land and property to the amount of nearly 3,000,000 pounds sterling. On the 10th and 11th July, the exact dates of the great storm on the Atlantic Coast, a terrific gale raged along the eastern coasts of Japan, causing heavy damage to moveable and immoveable property.

In Japan the South-West monsoon gives heavy rain to all the numerous islands, and the quantity of good top-soil washed down into the streams and thence into the sea is enormous. On the steep

mountain slopes referred to in a previous paragraph the productive elements of the virgin forest soil are washed out within a few decades, in spite of extraordinarily heavy manuring every year. The heaps of stones picked off the fields every year go on steadily increasing, the soil becomes rapidly shallower and shallower, and finally only a scanty crop of potatoes or buckwheat can be raised before the field has to be given up and allowed to be overrun with grass, bamboos, or shrubs. These, if left untouched, prepare the soil again for trees, the pioneers of agriculture. But actually nature is rarely left undisturbed in her work of restoration; the shrubby growth is cut over every two to five years, either for green-manuring or for small firewood, and thus nearly half the mountains are completely bare of tree-growth.

Inside the forest areas of the United States stock-breeding is a great industry. The farmer opens out the umbrageous leaf-canopy* by girdling or cut out trees everywhere in order to let in light for the growth of a rich crop of grass. Many slopes of the Alleghanies have already been thus prepared for stock-raising, and if we travel along the railroads through those beautiful scenes, looking out from comfortably and luxuriously furnished "parlour-cars," the mountains, the forests, the soil, and the cattle seem in the distance to be enjoying each other's company and to be all in tip-top condition. But if we leave the railway and climb over the fences, as I have often done, and take a nearer view of what from afar looked like forest, the trees will all be found to be standing scattered away from each other and degenerating into low branches. Being such, they cannot exercise much influence upon the soil and climate, and they even seem to be unable to prevent the heavier falls of rain from rushing down and scouring the mountain sides. If we follow the browsing animals, we shall find that at every step they slip back or forward from ½ to 2 feet, thereby tearing away with their sharp moveable hoofs the soil, which is thus constantly loosened and is washed away by the first heavy fall of rain. In a few decades these slopes, if once more left to themselves, will undoubtedly refuse to grow again the walnuts, hickories, or even oaks, which composed the virgin forest; but will probably not be able to prevent birches, poplars, and pines with spreading crowns from taking possession of it, particularly as the cattle eat greedily the seeds of the former trees, but carefully avoid those of the latter. What a prodigious

* This, we know, is the very opposite procedure to that followed by the forest proprietor in Europe, who does his best to maintain his leaf canopy as full as possible and thus to keep his soil in heavy shade.

change in the nature and constitution of the forest to be brought about in the course of fifty or even a hundred years by domestic animals!

We always find the finest forests on level ground, in valleys along the courses of rivers, that is to say, in the best soils, and it is such tracts that are first cleared and converted into fields. If the easiest mode of clearing away the forest is to use fire, "Use fire by all means" will say the pioneer settler, "for what objection can there be to employ the quickest means of getting rid of the heavy timber?" Perhaps many localities are too wet for field crops, "Drain them" will be his advice. But will he foresee, or, if he foresees, will he give a single apprehensive thought to the fatal consequences that must follow such an operation? The draining of the lower land will also *ipso facto* draw water away from the poorer, lighter, and looser soils below, which, being already deficient in moisture, will become further impoverished and may even become totally unfit for forest growth. In many instances the valuable broad-leaved trees will be replaced by what may be called *forest weeds, viz.*, birches, poplars, willows, alders, and pines. In others the white and red pine woods, which usually cover bits of rising ground within the hard-wood area of the northern forests, will degenerate or have to disappear before the invasion of an inferior pine, such as the black or the spruce pine.

The private owner of forest property naturally cuts down his best timber. Following a short-sighted policy, he removes all that can be sold or used up and leaves behind, to sow the ground and become the parents of the next generation, the unsound, crooked, and least valuable trees. Experience in Japan and other countries shows that if this new generation, which will be composed of inferior, light-seeded trees, forming a more or less open leaf-canopy, is left unmolested, under its fostering shelter will gradually appear young plants of the valuable species (from seeds dropped by birds and squirrels, if they are heavy-seeded species), and the forest will ultimately be restored to its pristine condition; but that if fire, fed with the débris of the exploitations, is allowed to sweep through the new generation, or the wood-cutter invades it year after year, then, in Japan at least, grasses and shrubs or a stunted scrub of scattered storm-beaten trees takes possession of the ground and any kind of restoration, within a reasonable time, of such areas without artificial aid becomes a hopeless matter.

The changes following upon the indiscriminate felling of forests will probably manifest themselves more rapidly in North America than anywhere else, since human activity is there far more intense

than in any other part of the world, and to this are added the indescribably wasteful methods of exploitation and a demand which always keeps ahead of the already vast supplies ever pouring in and is nevertheless alarmingly on the increase.

It is true that the area of forests on the North American Atlantic basin is still enormous; that the great variety of timber trees, which the changeable climate, with its rapid alternations of great heat and great cold, and of damp and drought, and the vast extent of the country and the great variety of soil have produced, is not equalled in any other part of the same temperate zone, not even in the forests of Japan. But my own opinion is that the forests which receive their supply of rain from the Pacific Ocean are still better suited for the individual development of trees and can bear a heavier mass of timber than even the forests of the Atlantic basin. The height of the Sequoias, the red firs, and the sugar pines of the Pacific sea-board of America, of the Cryptomerias of Japan, and of the Eucalypts of Australia and New Zealand, is not surpassed, much less reached, by any of the trees on the Atlantic sea-board, be it of America, of Europe, or of Africa.

It will very often happen that valuable timber-yielding species, if left to themselves, will be unable to struggle against inferior kinds and against injurious climatic influences, and thus disappear before them or be left in a hopeless minority. If on low-lying ground about an acre is completely cleared of trees in the midst of a mass of forest, a striking meteorological change will be at once manifest even in that limited area. The clearing will, in the language of foresters, have become a frost-hole, that is to say, in those holes in the forest the frosts will not only be more frequent and severe, but will also occur both earlier and later in the season than in the surrounding forest. Amongst the North American species seedlings of the heavy-seeded valuable oaks, walnuts, and hickory suffer much more from frost than the seedlings of the light-seeded birches, poplars, and pines; hence in openings made in the forest the action of nature will be to favour the appearance and establishment of the least valuable species to the disadvantage of mankind. But even in those places the valuable trees, temporarily driven out, will gradually reappear later on under the shelter of the less valuable ones, if the fire-fiend, one of the plagues of the New World, is kept out.

Another cause of change in the composition of a forest is also at work, to explain which I must crave the reader's indulgence and make a slight digression into the biology of forest trees.

Within the range of distribution of a forest tree there is always

a central region in which the tree grows in its highest perfection, and which may therefore be termed the *optimum* region of its habitat. Within this region the tree is more or less independent of the nature of the soil; while away from it, it becomes more and more particular in its exigencies in regard to soil, until near the limits of its range it absolutely requires, to be able to struggle successfully with its rival, a soil possessing certain well-defined characters. If a forest is cleared or destroyed by fire and the area is left entirely to itself to re-clothe itself once more with forest, all those species of trees will reappear, within the optimum of which the locality in question is situated, while all the rest for which the soil is not extremely favourable, will not enter into the new crop at all. Thus, to quote an example, if white pine woods situated anywhere between the 43rd and 45th parallels of latitude, which form respectively the southern and northern limits of its optimum region, are cut or burnt down, new crops of white pine will take the place of the original crop; but if such woods are cleared outside those parallels, the new crop will consist of broad-leaved trees or of a pine of inferior size and quality. The life-history of the trees of the North American forests has not yet been sufficiently studied to enable me to furnish many such instances in proof of the position I have established; and it would lead me too far to quote instances in point taken from the forests of Europe and Japan.

The influence of woodland on the climate (*i.e.*, on temperature, rainfall, humidity of the air, and movements of the atmosphere), and on the level of the water in rivers and springs, has been abundantly studied, and is still being studied at numerous observatories in Europe and North America, and very much has already been written on the subject. Nevertheless, as one of the subjects of this paper is to indicate and explain the gradual but steady climatic changes that are coming over a country, the forests of which are slowly but surely disappearing, I must earnestly beg the honourable readers of this journal to pardon me if I repeat here what they know full well already, and regarding which they may read in a mass of special publications. I may, however, perhaps claim for myself a more popular treatment of the subject than they will find in those publications, for I think we need no scientific apparatus to show how quickly nature turns upon us when her laws have been violated. Of what use indeed are a mass of scientific figures and other details to the popular mind, which, as a rule, does not trouble itself about the mean temperature or mean rainfall during the several months of the year, which is usually quite satisfied to know that it is warm in summer, warmer in some years than in others,

that all winters are cold, but that some may be colder than others, and which, at the farthest, may perhaps interest itself in remembering the temperature and rain and snow-fall of exceptional years. Thus for the mass of the general public, amongst whom must be included the great majority of the forest-owning class of the United States, scientific researches, and the conclusions based thereupon, must remain more or less of a sealed book. What they require are broad facts, which bring home to them, much more quickly than the observations and learned disquisitions of the meteorologist, the influence of deforestation upon the climate. To such facts, therefore, will I strictly confine myself.

Going back to the question of frost-holes, I can adduce a very striking instance from Java. Many forests have been cleared away from the foot and gentle even slopes of the great volcanoes for the planting of cinchona. These lands are situated at an elevation of about 3,000 feet above sea-level, and belong to the cooler region of the tropics, of which tree-figs, laurels, palms, and bananas may at once be named as the most conspicuous floral representatives. Here it has been found that it does not require to clear more than 100 acres to bring in frosts which injure the cinchona plants, whereas in the surrounding area and everywhere before the invasion of man frost was entirely unknown below an elevation of 7,000 feet. I need scarcely add that the Dutch planters are now careful to avoid clearing as much as 100 acres in one place in low-lying lands, thus depending on the surrounding forest to keep frost out of their plantations and generally to level down all climatic extremes. It is one of the great functions of forests to level down all marked irregularities of temperature, relative humidity, and soil-moisture.

By removing the forest growth from the smallest surface of land, we increase the tendency in it to extremes of temperature and humidity, and bring it nearer to the condition of the treeless region, the prairie. The temperature will be higher than before in summer and lower in winter, and the soil will be now drier, now wetter than it was ever before. This change may, in a certain degree, be of no consequence as far as the interests of agriculture are concerned. Indeed, I do not hesitate to declare my belief that in the case of northern countries with a mixed forest of broad-leaved species and conifers of, and allied to, the fir tribe, the clearing of forests will improve the temperature conditions for agriculture, for the higher temperature in summer will be useful to a greater extent than the lower temperature in winter will be harmful; there will be only one drawback, *viz.*, the increased risk from late and early frosts.

It is the general belief in Europe that the mean temperature of the year has not altered since observations have been recorded. We may grant that; but the mean annual temperature is no criterion at all for judging whether changes have or have not taken place in the peculiarities of the different seasons. Thus, if the heat in summer has increased to the same extent as the cold in winter, the mean will remain unaltered. For example, we all know what an immense difference there is between the climate of Baltimore and that of San Francisco, and yet the mean temperature of the year at both places is one and the same. But we have yet another reason for not relying too much on present meteorological records. It is only a few decades since observatories have begun to be established away from large agglomerations of population; observations taken in cities, and even small villages that are steadily extending and were surrounded by a broad strip of treeless land long before the commencement of observations, must surely be of no use whatsoever in determining whether any or what changes have been taking place in consequence of a decrease of woodland. A very slight further fall of temperature in the vicinity of the freezing point, in late spring or early autumn, or a momentary prolongation of an extreme temperature, may have fatal consequences in agriculture and forestry, and will yet certainly remain undetected by the meteorologist at the usual stations situated in the midst of habitations.

Another climatic factor unfavourably affected by the destruction of forests is relative humidity. The powerful influence exercised by the relative humidity of the air on forest vegetation has hitherto been entirely overlooked.* Although I had several times to refer to it in my first paper, I may repeat here that the result of a decrease in the wooded area is at once followed by diminished relative humidity, this effect being felt most during the hot season, when the largest amount of moisture is needed for the growth of high tree-vegetation. Observations to determine the mutual relation between forests and the relative humidity of the air have been instituted only very recently, and much, therefore, still remains to be found out. It has for a long time been accepted as an established fact that relative humidity and rainfall run concurrently; but no greater error than this assumption can be conceived. The prairie lying between the Rocky Mountains and the Missouri receives in May to August 130 mm. of rain, while the average relative

* It has certainly not been overlooked or even under-estimated in Fernandez's *Rough Notes for a Manual of Indian Sylviculture.*—[ED.]

humidity of the air during the same period is only 45 per cent.; on the other hand, in the prairie stretching along the coast of Southern California the corresponding figures for the same four months are respectively only 12 mm. and as much as 72 per cent. We may at once assume that no meteorological station situated in inhabited places far away from the forests can ever contribute any trustworthy data for the solution of the question before us. In Europe we have already our series of parallel stations, one set inside the forest, the other not far off in entirely open country.* The results furnished by those stations are most striking; the difference in the relative humidity of the air between the two sets of stations is from 5 to 10 per cent. in favour of the forests. In countries with a naturally moist atmosphere (above 70 per cent. during May to August), like Northern and Central Europe and the Atlantic coasts, a decrease of 5 to 10 per cent. in the relative humidity of the air will perhaps be harmless, as far at least as the growth of trees in height is concerned. But if we go westwards from the Atlantic into districts where the mean relative humidity sinks to 60 per cent. and lower, we need not be astonished if, after the devastation and disappearance of the forests with which those regions are now blessed, the climate frustrates all attempts to restore them by replanting, the seedlings being killed by drought and heat in summer and by dry cold in winter. It is not at all improbable that the prairie east of the Missouri River was once covered with forests, which, once destroyed, could not, unaided by man, return owing to the relative humidity having sunk at least 5 to 10 per cent. below the average figure at which forest-growth was formerly possible. It is, therefore, to be hoped that if ultimately the Americans determine to create a new forest there, it will be able to regenerate itself without extraneous help, and that if they begin by planting up in large close masses, they may thereby form centres of high relative humidity from which they could gradually work outwards till a line was reached beyond which every effort to raise trees must fail, *viz.*, nature's limit between prairie land on one side and forest land on the other.

Even in countries with a high relative humidity during winter and summer, the effect of a reduced relative humidity is clearly perceptible. Thus young seedlings planted out in the open, away

* The author is obviously not aware that we in India also have to a certain extent undertaken such observations, and would probably have still continued them but for the lamentable spirit at present militant in the Department, which keeps science and scientific work entirely in the background.—[ED.]

from their natural protectors, the grown-up trees, will suffer from drought in summer, for rapidity of transpiration will be in proportion to the dryness of the air, with the consequent danger of the absorption of water by the roots being unable to keep pace with the loss through the leaves. Again, we notice that in winter, plants bathed in moist air, *i.e.*, surrounded and sheltered by a mass of other trees, can stand greater and more prolonged cold than those plants which are exposed to free insolation and a dry atmosphere. It would lead me beyond the limits of this paper were I to dwell any longer on matters that are familiar to every practical tree-planter.

Regarding the effect of a change in the relative humidity of the air on the composition of a forest, we know what to expect in an area that has been denuded of its original covering of trees. Besides light-seeded, broad-leaved species, like the birches, poplars, and alders, the inferior pines will also gain the predominance, and those species which require the highest degree of relative humidity, such as evergreens with their tender shoots and leaves, cedars, cypresses, and Sequoias, will refuse absolutely to thrive under the altered conditions, or will at least be reduced to a very small minority.

But little is known regarding the effect of forest denudation on the rainfall of the denuded area, although many instances have been adduced to show that the rainfall diminishes if the wood area diminishes, and increases if the latter also increases. All these various instances are, however, open to some other interpretation as well, and involve a good deal of guess-work, and none of them can stand the ordeal of a strictly scientific scrutiny. My own opinion inclines to the belief that the influence of forests on the rainfall is very slight, if any at all. Forests, no doubt, increase very considerably the relative humidity of the air, but this effect is confined only to the area actually under forest and the immediate vicinity, and is not felt at all even a short distance off.

The influence of forests upon the amount of moisture in the soil and upon the quantity of water in the rivers can hardly be exaggerated. Quite recently the trees of a forest have been described as so many effective pumps for drawing water out of the soil, so that a soil under forest should be drier than the soil of open treeless land. This description may be true for excessively dry places, in which the soil under trees will be deprived of its moisture to a greater depth than completely bare soil or soil that is under grass or agricultural crops. A slight shower of rain may saturate the surface soil on treeless land, without a drop reaching the

ground below well-canopied forest. But if we suppose a steady downpour lasting only 24 hours, then we shall never be wrong if we assume that the soil inside the forest will be wetter and moistened to a greater depth than the soil outside. And why will this be so? Because the rain water, running down the branches and thence down the stems and roots, will penetrate with ease into the lower layers of soil reached by those roots, while the portion which drops off the leaves and branches will be greedily sucked up by the moss and the decaying leaves and vegetable mould covering the surface, and will from thence gradually filter down to lower depths. Besides this, owing to the higher relative humidity, lower temperature, and stillness of the air inside the forest, the moisture under the forest will evaporate more slowly than that from the area outside. Thus in summer, after one or two bright days succeeding a good fall of rain, the open country may already be in need of more rain, while inside the forest the roads are still wet, the soil still moist, and the air still cool and humid. All these are facts which cannot have escaped the least observant, and they are the facts that demonstrate the influence of forests on soil moisture in a manner clear and intelligible to everybody.

To study this question a little further it is necessary to distinguish between countries with a continental and those with an insular climate, and between these and those possessing a combined continental and insular (*coast*) climate. In an insular climate the rainfall is more or less equally distributed over the twelve months of the year, and the forests upon the mountains are required merely to prevent the precipitated water from rushing down headlong into the valleys and thence into the sea, carrying away all the elements of fertility of the soil. As the distance from the sea increases, the rain falls less frequently during the dry season; so that when we come to continental climates, we find that the forests on the mountain ranges have, in addition to the function just described, to fulfil the extremely important rôle of storing up the excess of moisture precipitated during the days of heavy rain and giving it up slowly and gradually to the plains below during the dry season when they require it most. Thus, in continental climates, the mountain forests are of especial value to the country, which would be a desert without them.

At the same time we must bear in mind that there are forests and forests. The type of a forest fulfilling all its highest functions is the virgin forest, in which under the complete canopy of gigantic trees, a lower storey of trees and shrubs fills up all the intervals between the straight, clean, pillar-like trunks, and the soil, com-

posed of rich mould and mosses, gives nourishment and shelter to thousands of seedlings and saplings of various ages. Such a forest, to be maintained permanently in as favourable a condition as possible, requires to be treated in the most systematic and conservative manner, none of the sheltering trees being taken out until the seedlings below it are ready to fill up the gap made by its removal. On the other hand, a forest of scattered trees, with a heavy growth of grass between, which, along with the débris that fall annually from the trees, is consumed every year by fire, such a forest, *sit venia verbo,* is hardly better than no forest at all.

Inundations, the result of exceptionally prolonged and heavy showers, occur as well in unpopulated tracts covered with virgin forests as in settled populous districts, yet what an enormous difference in their mode of occurrence and consequences! In the interior of the northern Japanese island of YESO (popularly corrupted into YESSO), poor in population, but rich in virgin forests, inundations are a common event. The rivers rise 6 feet and even more above their normal level, but not as a thundering swirling mass of thick muddy water carrying away entire uprooted trees. The colour of the water hardly changes, and the only spoils of the forest it bears away on its bosom are old decayed branches broken away by the water from overhanging prostrate trees dead years ago; and when the river has subsided to its usual level, no traces of the flood are left behind, no silt, no stones, and boulders outside the river-bed, no mud on the trunks of standing trees to mark the height of the swollen waters. Need I now describe an inundation in populated districts in which the forests have undergone the usual devastation? Hardly; but what is that thing left after an inundation which we, in our indifference, contemptuously call *mud?* Ninety per cent. of it comes from the forests, from the fields. It is the very best portion of the soil, the fertility, the wealth of the country drained away, and lost to it for ever!

Inundations have always occurred, and will occur again and again; all that we can do is to provide against their disastrous consequences, to prevent them from becoming catastrophes. In doing this work two entirely different professions must co-operate, Forestry and Engineering. They must come in the order named, the Forester first, the Engineer afterwards.

The forests in the plains, on low hills, and on good soil are the first to be invaded by the farmer and have to retire before him. This cannot be helped. But if we stick to the forests on the lower hills and keep them in their active and benevolent condition as

long as possible, and preserve strictly all the forests covering the mountains and steep slopes against every kind of spoliation and destruction, against all attempts of the agriculturists, against partition into small holdings, we may still be able to prevent, when excessive rain falls, the surface drainage from the low country from receiving an accession, from the hills and mountains, of enormous bodies of water laden with sand and stones and boulders, and thus reduce the volume and violence of the flood-waters, and save, or at least mitigate, the danger of an inundation.

The question of preserving the forests in the mountains being satisfactorily settled, the result will be that the flood-line of the rivers will once for all cease to form a constantly ascending curve, as is unfortunately at present the case with every river of the United States; and then the Engineers may be called in to take measures to control the flood-waters of the country below by regulating the beds and banks of the streams.

One need not have taken up the newspapers and read of the calamitous floods of 1887 in the United States to satisfy oneself that these floods are only the forerunners of greater disasters still to come. I visited many districts in the Southern and Central States over which the floods had just passed. The standing trees were covered with mud up to a height of 15 feet, and scattered about everywhere lay hundreds of forest giants, not fallen from physical decay and more or less rotten, but still green, which had been uprooted in the full vigour of their growth; these were all from 200 to 300 years old. I also found along the banks of rivers many strips of forest that had been partially swept away, and the trees here were also 200 to 300 years old. The fact that the uprooted trees were all from 200 to 300 years old does not, as one may easily imagine, at all prove that the floods which overturned them were exceptional ones, such as would not recur again for a similar period of years. It rather proves that those disasters are the beginning of a new era arising out of a totally altered condition of things, which are steadily growing still worse owing to continued and even increasing human activity. This prospect is not a cheering one, but it is not entirely hopeless, and if I, as a well-wisher of the great American nation, were asked for advice, I could not do better than admonish them in these words:—"Cut your trees, but spare your forests."

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THE FIRE-FLY—A RONDEAU.

A fire-fly! a floating spark,
A diamond dancing in the dark,
  A roving star, now low, now high,
  Anon afar, anon anigh,
Then soaring like a joyous lark.

It seems to feel nor care nor cark,
But drifts above the watch-dog's bark,
  And wheresoe'er it wills, doth hie
    A fire-fly!

It gleams along the heated park;
It rests upon the dry leaves—hark!
  Is that a flame beyond, which I
  Among their tinder can espy?
Ah, no! It makes no scorching mark,
    A fire-fly!

ADVENA.

UP THE TONS.

LEAVING Thadiar on the morning of the 31st, I struck up the left bank of the Tons along a road which, until the main road to Ramasarai branched off it, some two or three miles higher up, was fairly good, but after that it became little better than a sheep track. Below me in the river bed were alders, willows, Celtis, *Cinnamomum Tamala*, and others of the Laurineæ; but I looked in vain for the Engelhardtia, so common below Thadiar, until I had gone about four miles, when I saw a solitary specimen of it. Albizzias were very common, as was also the Rhus.

When once I had passed the boundary of the closed Government Forest, the chir forest, which clothed the slope above me, showed signs of the annual fires lighted by the graziers. In some places the trunks, half charred through, had been unable to withstand the wind and their large boles lay across the path. The burning of the grass seems to be carried out in a most systematic manner—not being burned all at once, but in patches in regular rotation.

Some of the chir trees here were, I think, the tallest I have seen, being *considerably* over 100 feet in height. A fallen one that I measured was 142 feet in the bole, and this, too, *in spite of the fact* that the point was burnt off. In some places the road,

or *path* rather, was lapped by the waters of the Tons; in others it rose some hundred feet above the river.

I camped that night on a triangular piece of ground which, although uncultivated, showed by a succession of terraces that it had once been tilled, probably before the Goorkha invasion, as chir trees as old as any in the surrounding forest covered it at intervals. On this piece of ground, which was nearly half a mile long by about 300 to 400 yards broad at the apex of the triangle, I found *Grewia vestita*, which, above Thadiar on the way to Deota a small tree, is here barely 18 inches high, with flowers and fruit on it. This was evidently owing to fires and grazing.

Noticing the hole made by a borer in a chir tree in front of my tent, I followed it up with my knife, and found that it did not penetrate further than the outer bark, and that the end of the hole was filled with grass seed, amongst which I failed to detect the insect that had made the hole.

Ficus Cunia with very large leaves was very common, as were also two or three other figs and several leguminous shrubs and small plants.

The waters of the Tons contain in suspension a large amount of mica and, where the floods had left *débris* on the bank, large quantities of it had been caught in the crevices of the soil, whilst on looking into the water minute particles of it could be seen flashing. The explanation of this I found afterwards when I went higher up, where all the streams tributary to the Tons had their beds in micacious rocks, which, where it was hollowed and smoothed by the action of the water, looked like enormous pieces of mother-of-pearl.

My next march was to Naintwar, to which place I had gone a little more than half way in my first day's march. The vegetation did not change, and the road was much the same as that of the previous day, save in one place, where it rose up the face of a cliff where some careful climbing was necessary. One thing worthy of notice at Naintwar was the difference in the colour of a stream which joined it from the north and that of the Tons itself. The clear blue of this stream, which seemed quite as large as the Tons, betokened its source to be a spring; but the snow-fed waters of the Tons quickly changed its colour into its own dirty grey.

At Naintwar I saw a piece of *dove-tailing* (if I may use the expression to designate a piece of work so unlike in all save the end obtained, what is understood by the original word), which I have never seen equalled.*

* *Dog-tailing* would not be an inappropriate term.—[Ed.]

I do not know what tools the villagers use; but the designs on some of the lintels of their houses and doors of temples show that they are no mean hands at carving after a quaint style of their own.

Next day's march took me to Sauré, some six good miles from Naintwar, and during this march the vegetation began to change considerably, probably owing to the fact that the road rose high above the river, which itself rose, or rather descended, from a good height, during the six miles. Hornbeam, poplar, spruce, blue pine, chestnut, walnut, and several other higher level trees, whilst at Sauré itself the ban oak mixed with the apricot.

On the way I passed a tree with a bole only 11 feet high, to which I was attracted by the large number of rings made by wood-peckers, and counted no less than sixty of them in the bole. Each hole was distinct, the bark of this tree evidently not splitting across so easily as that of the oak which opens out between the holes so as to form an unbroken ring.

At Sauré I was told that the road I had come was a *maidan* compared to the road I had to traverse! I should have been sorry to call it a *maidan* as compared to anything; but it certainly was not a bad road in comparison with that on which I found myself next day. In some places nothing but the roughened rock which composed the narrow ledges over which the road lay, prevented one from being dashed to pieces some hundred feet below. On the other side of a stream near Sauré I came across what was evidently a quarry for the slates which covered some of the houses in that village, and which they seem to pile on indiscriminately in a manner which speaks volumes for the strength of the structure underneath. The stream itself ran over a bed of the stones. I afterwards measured a piece quarried out higher up which was 4′ 9″ × 3′ × 2¾″. Many pieces of this size I should think would be enough to crush more substantial-looking houses in civilized places, and yet I saw even larger pieces on some of the houses. Shortly after leaving Sauré I came to a valley facing the north or right bank of the river. On its western side nothing but chir covered the slope, on the eastern side it was clothed with a dense growth of chestnuts, spruce, ban oak, and holly, with a thick undergrowth of ringals, raspberries, and Indigoferæ. Scattered here and there were the Rhus, brown birch, hornbeam, alder, and maple.

The next valley I came to was much the same with regard to vegetation, except that owing to a rocky soil the chir dotted both sides for some distance up before the other trees began. The road

here was very bad. In the next valley I came to, and where I camped that night, I thought I saw amongst other trees an ash. I could not get a specimen of it at that time, but on my return journey managed to do so.

My next day's march brought me to Datmir, which is at the top of a steep cliff rising from the river below. With the exception of the pull up this cliff the road was wonderfully good.

On the opposite side of the river the slope is clothed with deodar—the first place where I saw it in any quantity after leaving Deota—and on the top of the hill above the forest hut I also saw some of it as well as the first Bhojpatra I had seen. I did not go very close to the latter trees, and it was not till my next march (to Oosla) that I came within reach of a solitary specimen.

Round the forest hut at Datmir there were moru and kharshu trees, very old in appearance, some of them hollow, which had evidently been planted in rows. This circumstance I also noticed higher up near the village of Gangar, the rows varying from regularity so slightly as to preclude the possibility of their positions being accidental. There were box trees below the hut; but I saw none of any great size. Below the village is a large piece of ground under cultivation, and here I may mention that all up the valley the soil is wonderfully rich, even on the upper parts of the slopes. The chief products seemed to be dal, paddy, and chaulai. I found above the bungalow hazel and service trees, as well as the birdcherry so common at Deoban and Mundali.

My next march brought me to Oosla. On the way I passed through a dense forest of oaks, poplars, chestnut, maple, and brown birch with blue pine and spruce on the crests of the ridge, and alders along the water-courses.

It was not till next day that I came to pure forests of Bhojpatra on my way up from Oosla to Harkí Dún, my last camping place. There too I came across the shrub rhododendron with its lovely mauve flowers, and a tree which reminded me so much of the mountain ash of Europe (the "rowan" of Scottish song and story) that I had little difficulty in identifying it with *Pyrus ursina* in Brandis's "Forest Flora." In a piece of marshy ground about four miles above Oosla I found the first horsetails I had seen in the Himalayas, but on my return journey I found them at Kathyan.

At Harkí Dún itself, which is a flat piece of ground at the junction of three valleys with streams, any one of which might with equal right lay claim to being the Tons, Bhojpatra andsome wind-

blown silver firs, were the only trees of any height. Rhododendrons (*campanulatum*) were the last shrubs of any size, along with stunted willow. Above them came *R. Anthopogon*, juniper, willows turned almost into creeping shrubs, and last of all nothing but small hardy plants and flowers, most of them our ordinary home wild and garden flowers, amongst them being vetches, everlastings, yellow pansies, and strawberry plants with flowers of a blood-red colour, and rhubarb, which made a very good pudding without requiring too much sugar.

One plant which I noticed in particular was one which no one could help observing from the darkness of its maroon or claret flowers almost approaching blackness. It was one of the *Leguminosæ*, but its name I have not been able to ascertain.

It was not until on my way down that I found, about a mile below Harkí Dún, a hawthorn tree, the first and only one I saw.

Up the three valleys I have mentioned above I went on three successive days. All three, except that the one furthest south, had more stunted vegetation at the mouth of it than the others, were much the same in appearance—a plain covered with flowers up to a certain point, then boulders and fragments of broken rock, then snow, its surface yellow with dust, and after that snow in all its purity covering the sides of the slopes, and blocking up in dense masses some of the smaller hollows.

The valley to the north was the prettiest of the three, the stream which flowed down it broadening into small lakelets in two places, and its source, which I reached after four hours' steady climbing over boulders and snow drifts, I found to be another of these lakelets, which was, no doubt, increased by the melting snow, but must have been fed by a spring somewhere, although I could not see any signs of one. My reason for supposing that there was a spring was the fact that its upper side contained open flowing water, whilst its lower side entered and disappeared below a large drift of snow, whence it emerged some fifty yards lower down by a low-roofed cave, with frozen walls and roof supported on pillars of ice and festooned with icicles.

This I took to be about six to seven miles from Harkí Dún, whilst, as there was no snow there and here it was piled up, with its melted faces showing regular strata, I fancy I was some thousands of feet above my camp. I was shown a pass over this snow, by which I could have looked over the head of the valley, but it was too late to think of it, and it was all I could do, as it was, to get back before darkness set in.

The next valley I went up was the one to the southward. One thing about this one, as I observed above, was the fact that vegetation reached further up it; but this was not, I think, owing to its lying north and south, but to a curious fact which I shall endeavour to describe.

A little way above where my camp was pitched you crossed, by a rough semi-natural bridge, the streams from the north and north-east, and climbing about 30 feet higher up, you found yourself overlooking a large plain with a stream running through it several hundred feet below you, although the water behind you, and which is joined lower down by this stream, was only a few feet below you. In fact it is nothing but a ridge of impermeable rock, which prevents the two streams from the north and north-east from joining the third long ere they do so.

At a point which I guessed to be about eight miles from camp, the head of this valley took a bend to the northwards, and joined another leading down the other side, where I did not attempt to follow it. At the head of it there were the same snow-clad cliffs and stratified drifts in the hollows, which I noticed in the other valley. The stream which flowed through it kept losing itself under masses of boulders and reappearing again in the most unexpected places.

The walking over these boulders constituted the worst part of the walk up and down. It is tiring work walking up one side of a large boulder and down the other, or stepping from one to another without knowing when they are not going to turn under your foot. Imagine yourself walking over the ruins of stone-built houses for a mile or so and you will have some idea of it. To what depth this layer of stones reached I cannot say, but I certainly saw 12 or 15 feet down through it in places, and still I could not see the earth below. Sometimes these rocks were piled into little hills far above the level of the surrounding boulders; but whether this was owing to glaciers or to the simple falling of rocks from the cliffs above, I cannot say. Their toughness and jagged edges threw doubts on the former theory, whilst their distance from the bases of the cliffs belied the latter.

The third valley, the one to the south-east, after running for about a mile in a south-easterly direction, turned round towards the south. The vegetation below my camp was much the same along the river bank as that at Datmir. *Pyrus ursina* I found a solitary specimen of, but a little way above the river bank Bhojpatra had the ground all to itself.

I had intended to return by Thittakumta and Ramasarai, but

could not owing to unavoidable circumstances, so that my return journey was almost over the same ground as I covered on my way up, elms, hawthorn, and ash being the only trees added to my notes, and so ended one of the pleasantest trips I have ever enjoyed, the weather all the time being exceptionally good, and the cold, even at nights, being only slightly felt.

W. F.

A MORNING ON A KONKAN HILL.

A BROILING morning in the broiling month of May, the time between seven and eight. The sun is beating down mercilessly, and the hill that I am climbing is dreadfully steep and slippery. The grass has all got burnt up, and affords almost as treacherous foothold, at the angle at which it presents itself, as so much ice would. Steadily I mount, wishing fervently for a breath of wind to fan my perspiring brows, for, as I press on upwards, I "lard the lean earth" generously! Presently a sound not often heard in the Konkan jungles—at least in those in the neighbourhood of the sea—is heard, the cough, namely, of an irate or startled monkey, the well-known black-visaged *langúr*. Looking about, I soon spy one (a female evidently, as she carries a young one in her arms), seated on the top of a bare teak tree. She is in a state of violent excitement, and is swearing volubly, not, however, at me, but at something still concealed from my view. I throw myself (glad of any excuse for a halt!) on the ground and watch for the sequel. Shortly a village dog comes up, and then another, and another. My friend, the monkey, is evidently the object of their attentions, for, on reaching the tree on which she is seated, they pull up and surround it. Dark objects are visible here and there in the distance: these are "Khatkaries," a semi-wild tribe who inhabit the Konkan hills. They are the masters of the dogs, and monkeys, in various shapes, would apparently be found in their list of delicacies for the table. As the wild men approach, the monkey, thinking "discretion the better part of valour," betakes herself once more to flight. Carrying her young one with her and leaping from tree to tree, she rapidly ascends the hill, not touching the ground, and "the merry chase goes heedlessly sweeping by" within a few yards of me. I have had a first-rate view of the hunt, for I have gained a point on the hill above the line taken by the harassed monkey and her unrelenting pursuers, and have therefore seen everything splendidly. The silence in which the chase is conducted is most striking, both dogs

and men are mute, and the quarry also has relapsed into silence since resuming active flight. I had some Khatkaries with me, and asked them questions about the whole thing. They told me that a dog, single-handed, was no match for an ordinary-sized *langúr*, who could and would tear one to pieces very shortly, had the dog the temerity to attack it unaided. Three or four dogs were needed to pull down one *langúr*, unless of course a man was near enough to come in to aid at once. Monkeys are very greedily eaten by the Khatkaries. I heard afterwards (when returning from my inspection) that the baby-monkey had been killed, while the elder one had made good its escape—rather to my surprise, I must confess, as I did not think that the mother would have abandoned her young one under any stress of circumstances.

But my adventures were not yet at an end. Before leaving the hill, I heard again a curious sound. What is it? With ears pricked up and every nerve on the stretch I listen! No doubt of it; some one sawing up timber! "Rather cool!" I mutter to myself, and away in the direction of the noise we go, stalking as silently as the dry teak leaves will permit. My associates for the time being, the Khatkaries, hang back. "A fellow-feeling makes us wondrous kind," and they do not relish the idea of assisting at the probable capture of a fellow-tribesman. On we go cautiously, the excitement is growing intense, when the Khatkaries all at once begin pushing to the front quite eagerly. Anxious to know the reason of this sudden change, I enquire and am told, in reply to my queries, that the sound we hear has nothing whatever to do with wood; it is caused by a party of Khatkari women hunting for land crabs (in Marathi *kakeda*). Sure enough we presently espy the tinted Dianas, and, after a little parleying, the results of the chase (some two dozen crabs) become our property, their ultimate destination being the Natural History Society's Museum in Bombay. These crabs apparently lie dormant during the dry months under large stones and similar places of refuge, emerging only when the rains set in again. The wild people rub such large stones as seem likely to be places of retreat for their prey with other stones. The crabs mistake the sound for thunder! (no joke intended, for I got the explanation at first hand, on the spot, from the Khatkaries themselves). Under the belief that "Here are the rains again, hurrah!" they come out, are caught, and are in due time popped into the wild man's cooking pot, and thus fulfil one of the functions at all events for which they were included in Dame Nature's scheme. And so home.

G. K. B.

BREAD-MAKING.

In your endeavours to infuse into our minds the principles of scientific forestry you have hitherto overlooked a very important essential to success, namely, the necessity for disseminating, at the same time, useful hints in that special branch of knowledge by the aid of which we are enabled to maintain, in an efficient condition, the corporal foundation upon which depends the supply of the store of energy so largely drawn upon—by the exercise of our mental faculties—in our efforts to grasp and retain the great principles you teach.

I refer to corporal, as an aid to the capability of absorption of intellectual, sustenance.

Pabulum for the mind, of which you provide an inexhaustible supply, is, no doubt, very necessary; but this usually takes the form of very hard knotty points not easy of digestion: it may not, therefore be out of place here to offer (you having omitted to do so) to contribute towards the means by which the foresterial mind may be maintained in a fit state to assimilate the kind of food, often of foreign importation, which you generally provide for its nutrition.

Apart from this consideration, I feel sure that the Forest Officer, who is situated without the pale of civilization, will be most grateful for anything that will add to his home comforts, or that will tend to mitigate the severity of the "struggle for existence," which he continually maintains during the period of his sojourn in camp.

With these few prefatory remarks, I do not think I need offer any apology for seeking—even though it make your editorial hair stand on end—to desecrate the pages of our scientific journal by the introduction of so gross a subject as that of *Bread-making*. The subject, indeed, is an important one from every point of view.

For many years I have been the victim of dyspepsia, resulting from the consumption in large quantities (for I have a good appetite) of leathery chupatties, soda scones, woodeny biscuits, *et hoc genus omne*, all my efforts to procure a wholesome bread having proved abortive; but at last I have lighted upon a drunken cook (blessings never come singly) whose sole accomplishment (if his powers of imbibition be excepted) lies in the art of bread-making. At first he was not very successful, and his recipè naturally was a little "mixed," but by dint of perseverance I have succeeded in reducing it to something like intelligible order; and in the exuberance of my gratitude for having obtained a good, wholesome, palatable bread, I now hasten to impart the secret of its composi-

tion to my fellow-sufferers. Being ambitious I have endeavoured to word the recipè in the orthodox cookery-book style.

Recipè for making Bread.

To prepare the Yeast.

Take of

Sugar,	...	...	1 teaspoonful.
Flour,	...	...	1 dessertspoonful.
Hops,	...	...	1 teaspoonful.

Put the flour and sugar into a bottle; boil the hops in a breakfastcupful of water until the liquor is reduced to a quarter of a cup; allow it to stand till lukewarm; then strain and pour into the bottle over the flour and sugar. Shake the bottle well, cork and tie down. Put in a warm place for 48 hours, after which it will be ready for use. Call this (A).

When the above is ready, take of

Flour,	...	...	1 tablespoonful.
Hops,	...	...	1 teaspoonful.

Prepare the hot liquor as before and pour into a clean bottle over the flour; add to this a tablespoonful of (A); shake the bottle well; cork and tie down securely. This will be ready for use on the following day. Call it (B). The remainder of (A) may be thrown away.

You may now proceed to make your bread as follows:—Take of

Flour,	...	...	1 lb.
Salt,	...	...	1 level saltspoonful.
Sugar,	...	...	1 teaspoonful.
(B),	...	...	1 tablespoonful (in cold weather; half when the weather is warm).

Mix thoroughly with a sufficient quantity of lukewarm water and knead well; place it to rise within the influence of the heat of a fire (when the weather is cold), and when ready divide into two, put into shapes, and bake.

A fresh supply of (B) must be prepared *every day* (to be used in making the bread on the *following* day), with this difference only, that instead of the tablespoonful of (A) used in making the *first* supply, an equal quantity of (B) is to be substituted.

With ordinary ata this makes a most excellent brown bread, far superior to the stuff usually provided by the station baker. I hope that all who read and honestly try this recipè will, as in duty bound, be truly grateful to

1st September, 1890. A DRUNKEN COOK.

III OFFICIAL PAPER.

THE CULTIVATION OF ORANGES, LEMONS, AND FIGS IN INDIA.

A.—ORANGES.

The Santara.—The best orange grown for profit in India is the "cintra," a name commonly assumed to be derived from the Portuguese town, but lately declared to be a corruption of a Sanskrit word, which should be pronounced "suntura."

The tree which bears this fruit is of upright habit, in this country rarely exceeding 12 feet in height and 8 feet in expansion of branches. The leaves measure 1½ by ¾ inches and 2½ by 1¼ inches —the winged joint being very slightly developed, the flowers are ¾ inch in diameter, have 5 petals, 20 to 24 stamens, and 9 to 10 carpels. The fruit is found of two varieties, one having the skin remarkably loose and evidently overgrown beyond the pulp, and the other having a smooth tight-fitting skin. As grown at Nagpore, this has been declared, by people who have travelled much, to be the finest orange known in the world. The inner skin is very delicate, and the liths (carpels) so slightly cohering that it is easy to break up for the eating. Well-grown specimens have only two or three seeds. The flavour of the two varieties is equal, if grown under similar conditions; but the loose-skinned variety has an imposing appearance, and is rather more easily peeled, consequently it is the market favourite. Ordinary market specimens of the fruit average 8 ounces in weight, but 10-ounce specimens are common.

The Mozambique Orange.—The Mozambique orange *tree* is evidently a distinct species, of strong growing habit, producing an irregularly globular head and bearing leaves measuring 2¼ by 1½ to 5½ by ¾ inches, entire or very slighty and irregularly serrate, the apex being pointed or cut out. The leaf-stalk is ¾-inch, the wings on one of the joints attaining ¼-inch in width, often less and sometimes wanting. The flowers are 1½ inches in diameter, have 5 slightly oblique petals, which are glandular on the outside and 20 to 24 stamens. Average specimens of the fruit grown

in India weigh 8 ounces, but specimens of 13 ounces in weight imported from Mozambique are common. In shape it is globular, slightly compressed vertically; the skin is medium in thickness, tight-fitting, and marked by numerous small vertical furrows and a circular smooth mark, about 1 inch in diameter, on the upper end. The pulp is usually pale yellow, but when dead ripe becomes of a brownish yellow, that may be called the medium tint of orange pulp. In flavour it is sweet, but without the piquancy of the best varieties; the inner skin (endocarp) is tough, so that this orange can only be sucked. They keep in good condition about two months.

Ladoo Orange of the Deccan.—The tree which bears this variety produces long branches apt to spread out considerably as the tree attains size. The leaves are from 1½ by ¾ to 2½ by 1¼ inches, with the winged joint of the stalk very slightly developed. The open flowers are ¾-inch in diameter, of 5 petals, 20 to 24 stamens, and 9 to 10 carpels. The fruit attains 8 ounces in weight, is in shape a much depressed globe with a distinct nipple at the stalk, and within the skin on the upper end generally has an extra orange, about ¾-inch in diameter, with 5 to 7 liths (carpels). The skin is of a dusky yellow colour, moderately rough and loose, and of medium thickness; the inner skin (endocarp) very thin and enclosing juicy sweet pulp of piquant flavour and medium tint of colour. This is a fine orange, but it does not bring a high price, on account of its indifferent appearance.

Lall Ladoo of the Deccan.—I have identified this orange with the Mandarine orange of books. The tree resembles the "*Ladoo*" in habit, leaves and flowers, and shape of fruit, but the skin of the fruit is a deep orange colour, smooth, loose, enclosing 11 liths, having a stronger inner skin than "*Ladoo*" and 20 seeds—a very handsome, attractive fruit.

The Cowla.—A small-sized, indifferent orange, which becomes yellow on the tree before it is sweet.

The Sylhet Orange.—This is common in the Calcutta market, and is grown in the country whose name it bears. It averages 5 ounces, has a tight thin skin and good flavour. The Malta and St. Michael's oranges have been introduced, but are not making progress wherever it is possible to grow the "Cintra."

Cultivation of the Santara at Nagpore, C. P.—The finest oranges in India and, in the opinion of some, in the world, are grown near Nagpore, which lies in North Latitude 21° 9′ and East Longitude 79° 11′, about 350 miles from the sea, and at an altitude of 1,025 feet above mean sea level.

The orchards are fully exposed to the sun and on level ground, having a dark-coloured stiff loamy soil not less than 3 feet in depth, and overlying a sub-soil of open nodular limestone. The soil is formed of disintegrated basalt.

The climate may be described as comparatively hot and moist from June to September inclusive, cool and dry from October to February, hot and dry from March to May. It must be noted that the temperature is taken under standard meteorological arrangements, which require the thermometer to be shaded from direct sunshine and from radiation at night. The mean insolation or excess of temperature obtained by exposing the thermometer to the sun as compared with the shade temperature is 59·8, and the nocturnal radiation, or decrease from the shade temperature when the thermometer is exposed to the sky, varies from 12·8 in January to 2·7 in July.

There are two distinct seasons in which the trees will flower and ripen fruit; and to obtain high class fruit, the cultivator must elect which season to work, as the trees will not bear properly at both seasons. The finest fruit is obtained from flowers that open in June-July, and is on the market from February to May.

The second flowering is in February-March; this ripens fruit from December to February.

The trees are kept dry during May or December, according to the season at which fruit is wanted; at other seasons irrigation is carried on sufficient to provide, with the rainfall, at least 4 inches of water over the entire surface per month. The irrigation water is drawn from wells about 30 feet in depth, by means of a leathern bucket containing about 25 gallons, which is drawn up by bullocks that go down an incline, pulling a rope which passes over a simple pulley. The cost of drawing water 30 feet is about 1 anna (at par nearly 3 cents.) per 1,000 gallons.

The water is turned into small surface-channels made by drawing up a pair of parallel ridges, 18 inches apart and 9 inches high, and given a slope of 1 per 1,000. One channel serves two lines of trees, and from it the water is passed into sunk beds round the stem of the tree, extending as far as the sweep of the branches. About 1 to 2 inches in depth is given once in 10 days. The soil is kept moist from the flowering till the fruit is all gathered.

The soil is kept clean and open on the surface by ploughing 4 inches deep thrice yearly. For the crop that ripens during February, March, and April, water is withheld, the soil is opened up during April-May, and the roots exposed during 15 days, so that the trees get a check sufficient to cause the greater part of the leaves

to fall. Then 100 lbs. weight per tree of old, moist cow-dung of a reddish brown colour is mixed with the soil, and the roots covered up and watered heavily if rain does not fall soon. This causes the trees to burst into bloom and fresh growth ; thereafter the soil is kept moist till the fruit is gathered.

The same operation carried out in December brings ripe fruit during December, January, and February.

Suckers from below the graft must be cleared out, and weakly or decayed branches only cut out. Excessive pruning must be avoided, as it tends to cause the trees to "run to wood," and prevents flowering.

Fruit continues to attain full development during a month on each "break" of trees that has been started into growth together, and it is picked over at intervals of a few days.

A faint trace of yellow in the skin of the fruit indicates maturity. When fresh from the tree this fruit has a delightful rich piquancy of flavour that is to a great extent lost by being packed up for a few weeks, but the fruit remains in good condition two months, if not closely packed. No special curing is given, unless the fruit has been gathered unripe ; in that case close packing, with soft hay in a box is sufficient. Such fruit is always inferior. In packing, 30 to 40 lbs. weight of oranges are placed in very slim baskets without any packing, and the lid tied down. None of the fruit is shipped as merchandise.

The trees are planted about 12 feet apart each way.

Seeds of *Citrus medica*, a large coarse citron of vigorous habit, are sown, and when the stocks are two or three years old, budding is effected. The form of budding used is peculiar, and I think advantageous in unskilled hands. No transverse cut is made in the bark ; having made the vertical cut, the operator bends the stems gently towards the side having the cut. This causes the cut to gape open, and the bud having been inserted, the stock is released, and springs up, closing in the shield of the bud. A bandage consisting of a strip of banana stem is then applied. I think the want of the cross cut saves the gumming, that ensues if the cut is made too deep. Occasionally the sweet lime, *Citrus limetta*, is used as a stock, and it is believed by some to ensure more sweetness in the fruit. I have not proved this, and do not think it can affect the degree of sweetness.

The best varieties are invariably budded. Seedlings take so long to bear fruit as to be useless in practical fruit-growing.

The orchards generally measure from 5 to 10 acres.

The trees begin to bear at 3 years from the bud, carry the heavi-

est crops between the 6th and 10th year, and after the 15th year rapidly decay.

An important insect enemy is the caterpillar of *Erythro papilio*, which eats up the foliage during June-July. Hand-picking is the chief remedy employed. An undetermined wood-boring insect attacks the trees as soon as decay sets in, and is commonly supposed to be a cause of decay. I think it is rather a sign of decay. Hot tar poured into its holes kills the insect, but does not arrest decay when far advanced. If there is any sound wood left, it is advisable to cut back severely, but trees so treated do not fruit for two or three years after the operation.

It is doubtful whether any insects are beneficial, but the entomology of Indian fruit culture is as yet but fragmentary.

Lemons.—Lemons are not exported. The large Citron can be produced in quantity very cheaply, but, except by dyers for the acid, it is little used, and brings a very low price.

Note.—The latest edition of my own book is the fullest account available,* but that is superseded by this report, as far as oranges and lemons are concerned.

B.—Figs.

Figs are not dried in India to any considerable extent, as the local consumption absorbs the supply.

Varieties of figs are not named in India except with the name of the village they come from, which is not distinctive. The variety widely cultivated in the Deccan is inverted-conical, green at the stalk, and gradually deepening to brown at the broad end; it has alternating stripes of green and brown, and good examples weigh ¼ lb.

Village of Khed Shivapore, 14 miles south of Poona, which city stands in North Latitude 18° 28′, East Longitude 74° 10′, altitude of Khed Shivapore about 2,200 feet. Exposure to sun, full. Land of the orchards is nearly level, but the orchards are on the slope of a range of hills of 3,500 feet altitude. The altitude of the plantation is 2,200 feet.

The soil is a poor calcareous loam, sub-soil being marl, a mixture of lime and clay on disintegrated trap.

The temperature averages about 75 degrees; minimum, 48 degrees; maximum, 100 degrees. The village is shut in on the north, east, and west by hills, which keep out hot winds.

The rainfall is about 50 inches, falling chiefly from June to

* Since this was written, Dr. Bonavia's "Cultivated Oranges and Lemons, &c., of India and Ceylon" has been published.

October. The falling of rain sets the trees growing, and determines the ripening of fruit.

The irrigation is from wells, 2 inches per month from end of October till the fruit is ripe. Cultivators do not usually make special efforts to get sweet fruit, but the small quantity of water given has that effect.

The mode of cultivation is ploughing 4 inches or hoeing at end of rainy season.

The fertilizers used are village sweepings, 50 lbs., well decayed, per tree, applied after the crop is gathered.

After the tree has been caused to send up 5—7 branches from near the base by shortening the shoots sent out by the cutting, little, if any, pruning is given ; broken branches are cut out, and such as have gone higher than a man can reach with the hand, have the points taken off, and are cut out to the base after all the fruit has been gathered ; but the less pruning that is necessary, the better.

A few are grown as standards, the branches proceeding from the central stem at a height of 6 feet and spreading out horizontally.

The picking is done when the fruit is full grown, and shows a slight yellowing of the stalk. Early in the morning is preferred, because, if protected from the sun, fruit so picked retains a delicious coolness. For local use, each fig is wrapped up in a leaf when it has attained this stage, to protect it from birds, and is left on the tree a week longer. This improves the quality greatly, but carriage to a distance is impracticable in such a case. No boxing or curing is done in India.

The trees are planted 10 to 12 feet apart.

Propagation is effected by means of cuttings of 1-year-old wood planted in a shady bed in February.

The orchards are about 2 to 3 acres in extent only, because the situation on a hill slope does not admit of large level spaces fit for irrigation.

The trees live 15 years ; are fruitful during about 12.

The red spider is a serious enemy. No futile attempts are made against it by the cultivators; they think sacrifices to idols effectual.

The subject of fig cultivation has not yet been worked out.

I have never sent cuttings of figs so far as America, but I think that if cut in February, packed in moist sand in a tin box, and sent by post a few would survive the journey.

The latest edition of my book "Gardening in India" gives the fullest account available, but it is not as full regarding figs as this report.

Poona, 1890. G. M. WOODROW.

IV. Timber Market.

STATEMENT OF AVERAGE SELLING RATES FOR TIMBER AND BAMBOOS FOR THE QUARTER ENDING 31st DECEMBER, 1890.

At Meerut.

	RS.	A.	P.		RS.	A.	P.
Sál 10′ tors (poles), per score from	10	0	0	to	20	0	0
Sál karis, 12′ × 5″ × 4″ ,, ,,	25	0	0	,,	40	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	7	8	0	,,	12	10	0
Bamboos of 9′ to 10′, per 100 score, ,,	25	0	0	,,	80	0	0

At Cawnpore.

Sál 10′ tors (poles), per score from	0	0	0	to	5	0	0
Sain karis, 12′ × 5″ × 4″ ,, ,,	10	0	0	,,	12	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	4	0	0	,,	5	0	0
Bamboos of 9′ to 10′, per 100 score ,,	15	0	0	,,	30	0	0

At Bulandshahr.

Sál 10′ tors (poles), per score from	0	0	0	to	0	0	0
Sál, sain, &c., karis, 12′ × 5″ × 4″, ,, ,,	0	0	0	,,	0	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	0	0	0	,,	0	0	0
Bamboos of 9′ to 10′, per 100 score ,,	55	0	0	,,	60	0	0

At Pilibhit.

Sál 10′ tors (poles), per score from	40	0	0	to	70	0	0
Sál karis, 12′ × 5″ × 4″ ,, ,,	30	0	0	,,	40	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	5	0	0	,,	6	4	0
Bamboos of 9′ to 10′, per 100 score ,,	60	0	0	,,	100	0	0

At Bareilly.

Sál 10′ tors (poles), per score from	5	0	0	to	10	0	0
Sál karis, 12′ × 5″ × 4″ ,, ,,	50	0	0	,,	60	0	0
	25	0	0	,,	35	0	0
Sain karis, 12′ × 5″ × 4″ ,, ,,	25	0	0	,,	40	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	10	0	0	,,	15	0	0
Bamboos of 9′ to 10′, per 100 score ,,	50	0	0	,,	137	8	0

At Moradabad.

Sál 10′ tors (poles), per score from	20	0	0	to	25	0	0
Sál, sain, &c., karis, 12′ × 5″ × 4″, ,, ,,	30	0	0	,,	40	0	0
Sál bed-posts, 7′ × 2½″ × 2½″ ,, ,,	7	0	0	,,	10	0	0
Bamboos of 9′ to 10′, per 100 score ,,	50	0	0	,,	150	0	0

S. Eardley-Wilmot,
Offg. Conservator of Forests, Central Circle, N.-W. P. and Oudh.

SALE OF ANDAMAN PADOUK IN LONDON.

LAST month the brokers succeeded without difficulty in disposing of the lots offered in catalogue for absolute sale at fair prices, but were not so fortunate with the reserved portion, which no one in the room seemed inclined to entertain ; this was accordingly withdrawn. We do not hear of much inquiry at present, though there seems to be a fair prospect of its being increasingly used.

Ex Harrington @ Andaman Islands.

Without Reserve, Lots 192 to 213.

				Cub. ft.		
			No. 16 Shed.			
192	50	pks.	East India Padouk 3 in.	94	1/11	Dick.
193	103	„		343	2/4	Jones.
194	79	„		222	2/5	Young.
195	73	„		159	2/1	Sanders.
196	51	„		231	2/10	Young.
197	22	„		118	2/10	Young.
			Between 16 & 17 Sheds.			
198	58	„	5 in.	191	2/4	Sanders.
199	38	„		163	2/4	Lavy.
			No. 17 Shed.			
200	63	„	6 in.	239	2/3	Leary.
201	60	„		267	2/3	Hoar.
			No. 18 Shed.			
202	60	„	4 in.	156	2/2	Sanders.
203	59	„		184	2/3	Hoar.
204	80	„		323	2/5	Hoar.
205	75	„	6 in.	380	2/	Dick.
206	44	„	7 in.	224	2/4	J. B.
207	49	„		319	2/6	Dick.
208	48	„	8 in.	273	2/5	J B.
209	24	„		141	2/6	Dick.
210	21	„		121	2/7	Cobbett.
211	1	log end		6	2/	Sanders.
			No. 11A Shed, Junction Dock.			
212	Padouk boards,			550	all at £20	Hoar.
			No. 17 Shed.			
221	15	pks.	East India Padouk 6 in.	195	3/8	Shadbolt.
			No. 18 Shed.			
223	20	„	4 in.	141	3/6	Shadbolt.
224	60	„		255	3/	Lewis.
230	21	„		169	3/6	J. B.
232	36	„	5 in.	180	3/	Siemens.
235	31	„	6 in.	264	3/4	J. B.

Timber Trades Journal.

V. Notes, Queries and Extracts.

Early History of Forestry in India.—If the Fates are propitious, General Michael may yet do more towards a history of the early days of forest cultivation in India than is comprised in his recent much-too-brief letter to the Secretary of State. Such a history of those beginnings of things would be full of interest, not only to those who have in these latter days watched with keen attention the development of our great forestry organization, but to every student of the Empire's progress under the British *Raj*. It would be hard to say exactly what measure of the civilization and prosperity of the country is to be credited to the Forest Department. A mere glance at the formidable arrays of figures which comprise the bulk of the periodical reports on the subject reveals nothing, or next to nothing, while that curious (but hardy) annual, the "Moral and Material Progress Report," is content to dismiss the subject in a paragraph which does not even possess the merit of accuracy, inasmuch as it dates back the beginning of forest operations only to 1844, whereas they were commenced in Bombay as early as 1807, when Buonaparte was yet on the flood tide, when Russia was declaring war against England, when the nation was still mourning Nelson, and when his illustrious brother-warrior, Arthur Wellesley, after sweeping triumphantly through India, was earning new laurels nearer home. All that we know from the official returns is that there are now something over 60,000 square miles of forest reserves, and that the gross revenue arising from them is something like Rs. 1,34,90,470, or a net annual surplus of about Rs. 55,70,470. The remainder of our knowledge may be summed up in the statement of the Progress Report, that within the last twenty years forest laws have been enacted for, and forest administration has been placed upon a permanent basis in, every province of India; that the superior officers of the forest service have been selected by competition and have been trained in forestry either in Germany or in France, or at Cooper's Hill College, some of the subordinate officials being trained at a Forest school near Dehra in the sub-Himalayan country of the North-Western Provinces; and that, briefly speaking, the system is to select, acquire, and mark off as reserve

an area of State forest in every province sufficient to supply the wants of the neighbourhood and the province in respect of timber, firewood, bamboos, canes, and other forest produce, and sufficient also for supplying the foreign demand for such articles as teak-timber, sandal-wood, and rubber, these reserves being surveyed, conserved, and worked on sanctioned plans designed so as to obtain the largest possible permanent yield in the most ecomonical way, and private rights in the reserves being bought out or compromised. We know that in every province a very few of the most valuable timber trees are declared to be reserved trees, and can only be felled under special license outside the reserves, the country folk being allowed to obtain from the State forests timber, bamboos firewood, and grass for their own use free of charge, and inside reserves only persons specially licensed being allowed to extract timber or other produce on payment of fees; and we also know that forest revenue is raised by royalties on or by the sale of timber or other produce, and by issuing at specified fees permits to graze cattle, or to extract for sale timber, firewood, charcoal, bamboos, canes, and other minor forest produce. What General Michael has to tell us is the story of how this great organization had its beginning and in what difficult circumstances the work was begun and carried on or abandoned, as the case might be, and how out of many attempts in widely separated districts there grew at length under the eventual fostering care of Sir D. Brandis the organization we now know as the Imperial Forest Department. It was in 1807, as we have already said, that the earliest efforts were made in the direction of forest conservation, and these efforts were made in Bombay where the ship-building interest created a large demand for timber. In this year the Government issued a Proclamation assuming forest rights, appointed Commissioners to fix boundaries, and began a conservancy scheme on (for those times) a fairly extensive scale. There were many difficulties in the way, however. Private rights, it was alleged, were being encroached upon, and the efforts of the Conservators met with considerable opposition, and at length, fifteen years later, the scheme was practically abandoned. In Canara, as in some other districts, of which the record has been lost in one of the India Office holocausts, other schemes were in active force, and Colonel Gilbert was Conservator there for some sixteen years, being succeeded by Captain Jackes, of the Indian Navy, who was withdrawn when the district establishment was broken up in 1823-24. After a year or two's quiescence another experiment was made, and after that still others, but it was practically not until 1840 that any vigorous attempt was made to deal

with the subject. In that year the late Dr. Alexander Gibson, then Superintendent of the Bombay Botanical Gardens, was deputed to report upon the forest tracts of the Northern Division of the Presidency, and was subsequently appointed Conservator of Forests. Dr. Gibson worked under the Military Board, and an extraordinarily comprehensive system was formulated—much too comprehensive, as it afterwards proved, to give any satisfaction to the people generally, for complaints were again rife as to interfering with the ancient rights of the community. The attempts at taxation were strenuously resisted, the collection of timber, firewood, and jungle produce, was vigorously opposed, and Dr. Gibson and his officers often found themselves in an unpleasantly perilous position. Apart from all this, the operations did not pay; and in 1851 the Board recommended that the operations be restricted, and nine years later we find Dr. Gibson's appointment vacant. He had done very excellent work, however, and undoubtedly sowed the seeds of all our later operations. One of his efforts towards establishing conservancy, General Michael tells us, was the introduction of a measure under which heads of villages and landholders were entrusted with the preservation and working of forest tracts, receiving a small share of any profit derived from them. Both he and Dr. Stocks (who acted for him part of the time) were earnest and persistent in their advocacy of economy in forest matters and the preservation of their resources, says General Michael, and although their measures "savoured too much of a timber trade and a wholesale confiscation of ancient rights and customs, they rendered most valuable service to the cause of conservancy, which was then beginning to attract the serious attention of the Court of Directors."

Prior to acting for Dr. Gibson, Dr. Stocks had been Conservator in Sind, where a "Forest Ranger," as the office was then called, had been appointed in 1847. This was Major Scott, who was succeeded in turn by Captain Crawford, Dr. Stocks, Captain Hamilton of the Indian Navy, and Mr. Dalzell. The duties of the Ranger were to raise revenue from grazing fees, firewood, and jungle produce, and the sale of such building material as was procurable, and to ensure a supply of fuel for the Indus flotilla. The forests, however, contained little excepting babool (*Acacia arabica*), bahn (*Populus euphratica*) and "tamarisk" (*Tamarix orientalis*). "Wood is scanty," wrote the Ranger, in reporting to the Board, "brush being the rule, and wood the exception;" and here again the establishment did not pay, and Dr. Gibson, reporting on it in 1851, observed that though the forests defrayed the expenses of the native

management, the salaries of the European officers remained a charge to the State. Excellent work, however, was done by the officers named, and the measures they took to prevent waste, and the views they enunciated on the subject of conservancy and reproduction, were, the Records tell us, most useful to the cause. It was in this same year (1847) that General John Jacob began planting operations in the arid districts of the Upper Sind frontier, his main objects being to create shade and improve the rainfall and climate—objects which Sir Henry Green tells us he attained in a very marked degree. In the Tenasserim Provinces forest protection dates back to 1827. In that year Dr. Wallich reported on the teak forests, and proposed that the Government should take steps to preserve them. Six years were occupied in discussing the proposition, framing rules, and estimating consequences, and at length in 1833 a small native establishment was formed under the control of the civil authorities. Here as elsewhere, however, the old bogey of "ancient rights" cropped up, and the rules became a dead-letter. In 1837, 1838, and 1842 attempts were made at new rules, most of which were approved by the Government of India, but disapproved by the Court of Directors. In 1847 again Mr. J. R. Colvin, then Commissioner, endeavoured to form a forest department; but this also appears to have fallen through, for, when the Madras Government sent General Michael to the district in 1851 there was neither officer nor establishment. It was not till 1853 that a fair start was made, and after that things went on, comparatively speaking, uninterruptedly. In the Madras Presidency a scarcity of timber, owing to the large demands for the construction of the Bombay Dockyard and the ruinous methods by which the forests were worked by the lessees, provoked an experimental plantation at Nilambur, in Malabar. The work of Mr. H. V. Conolly, who began the experiment, was so much appreciated by the Government that it was gradually extended, until to-day there is a magnificent artificial forest in the district. Towards preserving natural forests, however, very little was done till 1847-48, when General Michael was appointed to take charge of the Annamullay forests in the Coimbatore district, and in course of time the work was extended on all hands. Not being hampered to any large extent by communal rights, the work was eminently successful, and it received additional impetus when in 1851 the British Association drew attention in England to the urgent need which existed for extending such work throughout India. It was the Madras Government in these early days which was the first to enunciate the principle that the conservancy of forest resources was the primary, and the

acquisition of revenue but a secondary, consideration in forest work; and it is in pursuance of this principle that the work has shown such excellent results. In 1855 General Michael retired owing to ill-health, and was succeeded by General (then Captain) Douglas Hamilton. In 1856 Dr. Hugh Cleghorn was appointed Conservator of Forests, with Captain Hamilton, Lieut. Beddome, and Dr. Drew as his assistants, with a suitable subordinate establishment, the whole costing no more than Rs. 5,000 per mensem. This was the real beginning of the Imperial Forest Department, although it did not actually take that form till 1862-64. Forest work then became general, and has gone on progressing, till it has reached the important place in the Imperial Government which it enjoys to-day.—*Times of India.*

OIL-YIELDING TREES OF BURMA.—The publication of a revised form of license for the collection of wood-oil on lands at the disposal of Government not included in a reserved or village forest in the last issue of the Official *Gazette* reminds us of another and valuable source of natural wealth in the province, which might very well engage the attention of the capitalist seeking for some profitable investment in Burma.

Wood-oil or resin, the yield of a number of splendid members of the vegetable kingdom, may be obtained in most parts of the province at very little cost of time and labour. Some of the trees yielding it are so widely spread that they may be met with in most forests from the frontier towards Chittagong and Tipperah down to Tenasserim. They may also be met with in the various islands of the coast; and many of the kinds, which yield the *kanyin*, possess stems of fine girth, shooting up above the soil to a towering height without a branch to mar their straight outline. Magnificent specimens of a clear stem 15 feet in girth and over 100 feet in height are not uncommon in the tropical forests of Pegu, Tenasserim, and the Andaman Islands, and these are species of that natural genus so common in Burma—the *Dipterocarpus*—the two-winged fruit of which whirl about in the atmosphere previous to finding a genial abode in the virgin soil of the forest. Of *kanyin* the Burmese distinguish two varieties—the red and the white—and both, besides yielding oil, supply a kind of timber which lasts very well, and is used for planks in such parts of buildings as are not exposed to wet. The timber, however, is not so valuable as the oil, extracted generally by tapping, and is much inferior to teak, unlike which it is exposed to the attacks of

the white-ant. Some species yield a pale brown wood, others a yellowish grey timber, and one, in addition to oil and wood, yields a resin of a fine brown colour, which has not yet been turned to any account. The *en* or *eng* belongs to the same natural order and genus, it also being a *Dipterocarpus*. But the *eng* gives no oil. A resin of a clear yellow colour exudes from it, and its timber is more valuable than those of the oil-yielding species. The tree abounds on sandy soil in the vicinity of the sea as well as in the interior. Its timber is of a brown colour, a cubic foot of it weighing 55 pounds, and capable of being worked up very well. For in-door use it answers very well where economy is an object, as, protected from wind and rain, it lasts pretty long. It is extensively converted into planks, and sold readily in places where teak is out of question in consequence of its higher price. A great deal of difference of opinion exists as to the value of the timber of this tree, owing, no doubt, to the Burmese applying the name of *en* or *eng* to more than one species. It is the same with *kanyin*. Full information as to the supply and economic uses of the Burmese wood-oils is as yet a desideratum.

But besides *eng* and *kanyin*, Burma—especially Lower Burma, with which we are just now more familiar—contains a number of other valuable oil-yielding trees, which have not as yet received that attention at the hands of the public which they fully deserve. One genus, for instance, is the *Gonarus*, two species at least of which are deserving of notice. One is a large tree, very plentifully to be met with almost everywhere, and remarkable for the immense quantities of seeds it yields—seeds abounding in a sweet oil. The other is a smaller tree, about 10 feet in height, also plentiful, but yielding smaller-sized seed; the seeds, however, are just as rich in sweet oils as its larger kind.

There is that denizen of tidal and beach forests with its middle-sized purple flowers known technically as the *Pongamia glabra*. This is another oil-yielder. It is very well known in India, being often grown in hedges. Its oil, known as *karanj*, is reddish brown and thick, and used both for burning as well as skin disease. In Burma the plant is known as *thinwin*, and may be met with in all districts from Tavoy to Toungoo. The tree often attains a height of from 40 to 50 feet. The Burmese obtain the oil by expression, and use it as an embrocation as well as for burning.

Besides these, in the open dry forests, from Prome to Tenasserim, are the two species of *Buchanania*, known as *lunbo* in the vernacular. Both are freely met with, and both yield an abundance of oil-seeds of the sweet and fatty class. In India the kernels are sold as a

substitute for almonds, and so prized are they as a sweet-meat when cooked, that the oil is rarely to be had in any quantity. It is pale straw-coloured, limpid, sweet, and wholesome. Passing over some less important ones, we would next mention the *Illiepie* of India, growing plentifully in the vicinity of Prome. Some mistook this at one time for the European Olive, but our Forest Department exposed the error, and showed the plant to be a species of *Bassia*—the species with the long, slender leaves, closely allied to the broad-leaved kind so common and well-known in India. The *Bassia* family is a valuable one to the natives. The broad-leaved kind yields the *mahwa*, a fruit which gives in times of famine bread to the hungry, and at all times a spirituous liquor to the thirsty native. Closely related to it and the *illiepie* is the "butter-tree." The oil from this last species, being cheaper than *ghee* or fluid butter, is frequently used as an adulterant. It is also burnt in lamps. In medicine it is highly valued for its efficacy in rheumatism and contraction of the limbs. Perfumed with cloves and attar of roses it is used as an ointment by the wealthier natives. Mixed with scented oil, it is applied to the hair as a valuable preservative.

Such are a few of the most common of the oil-yielding trees to be met with in Burma; and if we notice them here it is with the same object with which we have noticed other natural products of the province, namely, to attract the notice of capitalists to our natural wealth. As we have had occasion to say it on more than one occasion, there is a wealth of wood, oil, gum, resins, fibres, minerals of all kinds to be found in the province, all awaiting only the touch of intelligent enterprize to award the fortunate investor with wealth beyond his most sanguinue expectations.—*Rangoon Times.*

VITALITY OF SEEDS.—With very few exceptions, all seeds retain their germinating power for at least a year under ordinary conditions; and, when placed in circumstances specially favourable, they remain fresh for a very lengthened period. Several remarkable instances of this have already been mentioned, but cases even more remarkable than these are recorded. In the ground, when buried deeply, the length of time seeds will retain life is indefinite —according to some authorities, even unlimited. The accounts of seeds which had been taken from ancient Egyptian tomas germinating on being placed under favourable conditions, and other similar cases of an astonishing nature might be mentioned. These are,

however, of little or no practical moment, beyond showing us how wonderfully tenacious of life is the tiny germ which lies enclosed in its often thin and delicate wrappers. How long a seed will remain good when placed under the conditions supplied in the seed-house, or when sown and treated for germination, is a question to which we may turn for more useful information. A seed when properly matured and kept dry in an even and suitable temperature will remain healthy for a less or more lengthened period, according to whether it is oily or starchy, or whether it belongs to the albuminous or the exalbuminous kinds. Oily seeds usually perish in a comparatively short time, so that it becomes necessary to sow them as soon as possible after they are ripe: such seeds are those of tea, coffee, camellia, theobroma, acorns, Brazil-nuts, walnuts, &c. Seeds of a starchy nature are generally much longer-lived. It is, however, impossible to draw a hard-and-fast line between long-lived and short-lived seeds, as there are so many conditions other than those we perceive, and often altogether beyond our control, which affect the vitality of seeds. Lindley says:—"Seeds are probably possessed of different powers of life, some preserving their vital principle through centuries of time, while others have but an ephemeral existence under any circumstances. The reasons for this difference are unknown to us." In the case of many of our most popular and long-culivated plants, however, we have data sufficient to enable us to perceive how long their seeds may be expected to remain capable of germinating. The following list was prepared by the well-known seed-merchants, Vilmorin-Andrieux & Co., of Paris, and with it is incorporated a portion of a list printed in Burbridge's *Propagation and Improvement of Plants*:—

Average duration of the germinating power of the seeds of some cultivated plants.

	Years.		Years.
Acacia, ...	Many.	Beans, Kidney, ...	3
Alder, ...	1	Beet-root, ...	5
Amaranth, ...	5	Borage, ...	3
Angelica, ...	1	Burnet, ...	2
Anise, ...	3	Cabbage, ...	5
Artichoke, ...	5	Capsicum, ...	4
Aster, China, ...	1	Caraway, ...	2
Asparagus, ...	4	Cardoon, ...	7
Balsam, ...	Many	Carrot, ...	4
Basil, ...	6	Chervil, ...	2
Beans, Broad, ...	6	„ Tuberous, ...	1

Average duration of the germinating power of the seeds of some cultivated plants—(concluded).

	Years.		Years.
Chicory, ...	8	Peas, ...	4–5
Corn Salad,... ...	5	Potato, ...	4
Cress, ...	5	Purslane, ...	8
Cucumber, ...	5	Radish, ...	5
Egg Plant, ...	7	Rampion, ...	5
Endive, ...	9	Rhubarb, ...	3
Leek, ...	2	Rocket, ...	2
Lentil, ...	3	Rosemary, ...	4
Lettuce, ...	5	Salsify, ...	3
Maize, ...	2	Savory, ...	2
Mallow, ...	5	Scorzonera, ...	2
Marjoram, ...	2	Seakale, ...	3
Melon, ...	5	Sorrel, ...	2
Mustard, ...	5	Spinach, ...	5
Nasturtium,... ...	5	Strawberry,... ...	8
Onion, ...	2	Thyme, ...	2–3
Parsley, ...	3	Tomato, ...	5
Parsnip, ...	2	Turnip, ...	5

The above table does not profess to give in every case the longest time possible for the seeds to remain good, but only the average time during which, under the conditions supplied in the ordinary seed-room, they might be expected to retain their power to vegetate. Cabbage seeds have been known to germinate after being kept for ten years, and kidney beans after five years. As above stated, the conditions which affect the duration of life in seeds are too often beyond control, or altogether hidden from us.

It has been already pointed out that under certain conditions some seeds will remain dormant in the ground for a long time without losing their vitality ; in like manner seeds will sometimes lie for years without commencing to grow, even when the conditions under which they are placed are what we consider favourable to germination. Lindley mentions various instances of this, all tending to show how necessary it is to have patience in the management of seeds, and more especially when the age of the seeds is unknown. Old seeds always germinate more slowly than young ones, the hardening of the testa or seed-coats through long exposure, no doubt, accounting to some extent for their tardiness in starting. By steeping in warm water or by removing the outer shell from seeds, germination, as shown above, is much forwarded.

Fruits of hawthorns, hollies, birch, and other hardy berry-bearing trees are generally subjected to a softening process before their seeds are sown. This process is what is termed the "rot-heap," and is managed as follows :—The fruits are gathered in the autumn as soon as ripe, and are thrown in heaps, a quantity of sand, ashes, or light soil is mixed up with them by frequently turning them ; they are then buried in a pit or placed in heaps and covered with turf, where they remain till the following spring. The whole is then prepared for sowing by partly drying and then sifting. In this manner the seeds are separated, whilst the warmth and moisture in which they were stored through the winter has softened the hard shell of the seeds, and, no doubt, has excited the germinative process.

Seeds of plants belonging to the Ranunculus and Primrose families sometimes remain in the ground for several years without moving. Mr. Anderson Henry states that some seeds of *Ranunculus Lyalli,* the Shepherd's Lily, sown by him in 1878, did not germinate till 1881 ; and in the case of seeds of a second species of *Ranunculus*, germination took place four years and a half afterwards. The same extraordinary slowness has often been observed in seeds sown at Kew. How far this slowness to vegetate may be considered as natural to the plants, or whether it is due to some untoward influence to which the seeds had been subjected, is not clear. Seeds of *Ranunculus Lyalli* vegetated in about eleven months at Kew. I suspect that with most of those plants, the seeds of which usually remain in the soil a long time before growing, it would be better to sow the seeds immediately on their becoming ripe. Mr. A. Henry found *Primula japonica* and gentians slow to germinate, but when the seeds of these plants are gathered and sown as soon as ripe, they generally germinate in a few weeks. It is said that colchicum seeds generally take over two years to start into growth. It is always best to select the largest and heaviest seeds in all cases where robustness of growth is the first aim, smaller seeds being slower to get away, and containing less vital force than larger ones of the same kind. It is also supposed that large seeds retain life for a longer time than smaller ones do.—W. Watson in "Cassell's Popular Gardening."—*Gardeners' Chronicle.*

CARNIVOROUS PLANTS DEPENDENT FOR THEIR DIGESTION OF ANIMAL FOOD ON MICRO-ORGANISMS.—When Darwin and other naturalists made their experiments with the so-called carnivorous plants, the

importance of micro-organisms was not realised, and hence their results are questionable. In 1875, M. Edouard Morren investigated the behaviour of the *Pinguicula* and *Drosera*, and arrived at a conclusion quite different from the opinions of Darwin on these interesting plants. Another series of experiments on the *Nepenthes* has been undertaken by M. Raphael Dubois, whose results have just been communicated to the *Académie des Sciences*, Paris. Sir Dalton Hooker considered that the carnivorous attributes of the *Nepenthes* was beyond a doubt, but M. Dubois has found reason to differ with him. His observations were made on a great variety of these plants at the botanical gardens of the Tête d'Or, Lyons, for example, the *N. Rafflesiana*, *Hookeriana*, *coccinea*, *phyllamphora*, *distillatoria*, *hybrida*, and *maculata*. The urns of all these plants enclose, before the opening of the operculum or cover, a limpid liquid, slightly acid. When the operculum opens, the liquid seems to putrefy, and the vestiges of insects are found in it. M. Dubois found that if the liquid was drawn from the still-closed urn by means of a sterilised pipette, it continued limpid for several months, and when first drawn had no effect on coagulated albumen, even if heated to a temperature of 35° or 40° C. When filtered at the end of several hours it contained no peptones. Nor were any micro-organisms found in the pure liquid of the closed urns, or any trace of putrefaction. Only a *Torula*, similar to the yeast of beer, was noticed at times, but its presence and purpose there has not yet been fully examined. On the other hand, when the liquid was drawn from urns which had been open some little time, and was still clear, it rapidly attacked the albumen (little cubes of white of egg) which became transparent and gelatinous, and lost its angles. In some cases the liquid became putrefied. It was found to swarm with diverse micro-organisms, and after filtration gave some of the reactions of the peptones. Many of the open urns contained insects, but in process of putrefaction, not of digestion. Fresh fibrine was not used in these experiments because it dissolves in certain liquids without there being a true digestion, and because it would have been cooked during the sterilisation. Nor was cartilage used, because it would have been partially transformed into gelatine. M. Dubois concludes from his researches that the liquid of the *Nepenthes* does not contain a digestive ingredient like pepsine, and that they are not carnivorous plants. The phenomenon of false digestion observed by Hooker was, without doubt, caused by micro-organisms which had entered the urn from without, and were not secreted by the plant.—*Indian Agriculturist.*

VEGETATION RETREATING DOWNWARDS ON THE ALPS.—Vegetation appears to be retreating on the high Alps. Mr. David Martin, a geological surveyor, has observed that the rhododendron is not found above a height of 2,000 metres, whereas 20 years ago it flourished at 2,350 metres. Birch, pines, &c., disappear at an altitude of 1,800 metres, except in certain parts exposed to the moist winds of the north, where they reach 2,300 metres. Lower down, the vine, which formerly grew at Valgourdemar, an altitude of 1,050 metres, is only seen to-day at a height of 850 metres. Poplars are nearly all dead upon the crest of the hills. This retrogression of vegetation has also been observed in Siberia, and, among other places, in Savoy, and at the Grande Chartreuse. Mr. Martin thinks that owing to the disappearance of glaciers the trees suffer from drought in summer and extreme cold in winter, against which they are not sufficiently protected by the snow.—*Indian Agriculturist.*

SOIL INGREDIENTS.—A recently published report of the University of California gives some instructive notes on soil ingredients, from which we cull the following :—

Potash.—Of the three critical mineral soil-ingredients—potash, phosphoric acid, and lime—the first seems capable of the greatest variation in percentage amount, without materially affecting the productiveness of the soil. The minimum known to me to be found in any productive soil is on the coast of Mississippi, *viz.*, an average of ·05 per cent. in the soils of the sea-island cotton plantations. But these soils are remarkable for their sandiness, great depth, and (relatively) high contents of lime and humus. Elsewhere and especially in the (non-calcareous) pine flats and uplands of the south, soils of such low potash percentage are very sterile, even when accompanied by fair proportions of phosphoric acid. The ordinary figures for "pine uplands" there range between ·150 and ·250 per cent. ; such soils "wear out" within four or five years, but even these seem to be best restored by the use of simple phosphate manures, or by marling, while the commercial potash salts have found little favour. Definite experiments on the subject have been few and unsystematic. In the oak-and-pine uplands of Mississippi the potash percentages range from ·30 to ·45 per cent., although in the highly productive and durable "oak uplands" along the Mississippi from ·60 to ·75 per cent. is the rule. Thus, in these uplands the increase of productiveness and durability runs almost exactly parallel to the potash percentage. But in the

highly productive and durable prairie soils of the same State the presence of much lime and humus profoundly modifies these relations, and much smaller proportions of potash are common in very productive and durable lands. Hence it can only be said that as between soils of similar origin and general character, the potash percentage is an important index. So far as experience goes, I consider that no virgin soil having ·50 per cent or over of K_2O will wear out first on that side of its store of mineral plant-food and much less will suffice in the presence of much lime and humus.

Lime.—The influence of lime upon the physical and chemical character of soils is so potent, that the determination of its presence alone amply justifies the use of chemical analysis in the examination of soils for practical purposes. The most cursory observer cannot fail to observe the change that occurs not only in the natural vegetation, but in the prosperity of the population, wherever a calcareous soil-region adjoins a non-calcareous one. That this fact has not been as fully appreciated as it deserves is due simply to the neglect of soil analysis generally, and more specially of that of virgin soils, where these effects are unobscured by the intervention of man.

Effect of Lime on Humus.—Upon the basis of laboratory experiments with mixtures of lime with various organic substances it has been held that the presence of lime in soil tends to the rapid eremacausis of humus, and hence calcareous soils should be poor in the latter substance. The analyses of natural calcareous soils show the contrary state of things ; and the intensely black colour of the confessedly calcareous "prairie soils" of the West contradicts the above assumption, convincingly, even to the eye of the passer-by. A "gray adobe" or clay soil is invariably poor in lime ; a black one, rich in lime as well as in humus. The coal-black tint of calcareo-humic soils must not, however, be confounded with the brown one of peaty (ulmic) soils, which, however, become black when treated with doses of lime sufficient not only for neutralization, but for the continuation of that action which is so well and effectively known in the case of manure piles to favour the humification of the litter. In the arid regions the only black soils are highly calcareous ones. So far as the evidence goes, lime is entitled to be considered the conservator of humus in natural soils.

How much lime is required to secure these advantages?—Taking as a guide the evidence of the natural growth, as well as that of the results of cultivations, it becomes evident that the amount of lime required to render a soil practically a "calcareous" one varies

greatly according to the nature of the soil. A broad statement may, however, be made, to the effect that the amount is very much greater in clayey soils than in sandy ones, and may approximately be said to vary directly as the amount of clay in the soil. Thus, in the very sandy soils of the sea-island cotton plantations on Mississippi Sound, the presence of as little as ·115 per cent. of lime gives full sway to lime growth; but in the ill-drained "pine meadows" of the same region, ·025 per cent. leaves the land sour and sterile. On the other hand, in the heavy clay soil of the central portion of the State, ·42 per cent. of lime does not suffice to produce a lime vegetation, but ·48 per cent. on a similarly heavy soil, shows the characteristic crab-apple and haw of the calcareous prairie soils. Precisely similar observations in Louisiana and California amply confirm the same general conclusion. Direct comparison of a great number of intermediate soils—loams, from sandy to clayey—confirm the same general rule, for the arid region as well as for that of summer rains. Loams whose moisture absorption ranges from 4 to 6 5 per cent. require from ·20 to ·30 per cent. of lime to show lime vegetation; the latter takes full possession when the lime percentage rises to ·50 per cent., and a further increase appears to influence the soil more from direct physical action than from chemical causes. I have not seen any advantages to accrue to a soil from an increase of lime beyond 1·5 to 2·0 per cent., except that heavy clay soils are somewhat lightened by granular carbonate. These facts, elicited from actual observation in the field (cultivated and uncultivated) and their comparison with the result of analysis, change materially the proper definition of "calcareous soils" from that given in the text-books of agricultural chemistry. *A priori*, it is not easy to see why any special change should follow the presence of an excess of lime over the amount required to keep the soil constantly drenched with a saturated solution of calcic carbonate in soil water.

Magnesia.—However necessary magnesia may be as an ash-ingredient of plants, it does not seem to exert any important direct action upon the soil as such, so far as comparison of the experience of cultivators and observers of virgin soil can discover. In the soils of summer-rain regions, magnesia generally exceeds lime in its percentage; in moderately calcareous soils it most commonly approximates to lime in amount. Soils of very high contents of magnesia are usually poor in other respects on account of the derivation from talcose or serpentinous rocks.

Manganese.—I have vainly sought to connect this metal with any special soil-feature, either intrinsic or connected with its produc-

tion. While omnipresent, and sometimes quite abundant in the poor "pine woods" soil of the south, whose pine straw contains unusually large proportion of manganese in its ash, its presence, if of any consequence to plants, seems to be amply provided for by nature. I have always determined it in soil analysis because it is there, and for the sake of other determinations must be precipitated.

Iron.—I know of no soil whose contents of ferric oxide would not be more than ample to supply all the needs of vegetation, so far as direct absorption is concerned. Its ascertained percentage rarely falls below 1 per cent. and more commonly ranges from 2 to 5 per cent. A curious fact amply illustrated by analysis is that soils of high ferruginous colour do not always contain unusual amounts of the ferric hydrate, the colour apparently depending more upon the mode of distribution than on the quantity. This is obvious enough in soil containing bog ore in visible grains; but in many cases it appears to be a semi-crystalline aggregation of the substance around particles of soil and sand that hides the tint. The almost universal preference accorded to "red" soils as against gray or whitish lands in the same soil region, has given rise to the proposition to render the latter classes equal to the first by the addition of iron in some form, even to the use of magnetite sand and iron scraps. It need hardly be said that the true cause of the preference given to red lands is chiefly that the presence of this colour indicates good drainage, whereas in the corresponding "white" lands the iron has usually accumulated in the subsoil in the form of bog ore in consequence of stagnation of water, forming a subsoil in which the process of reduction may recur at any time, and in which (as analysis has shown and as might have been anticipated) a large proportion of the phosphoric acid of the soil has been accumulated and locked up. A red soil is a "safe" one, and is usually freed from the need of artificial under-drainage. That the colour imparted by ferric hydrate favours the absorption of heat is another recommendation of red soils; they are "earlier" than those of white or gray tints. Moreover, as direct determinations show, well-diffused ferric-hydrate is powerfully hygroscopic, and adds materially to the retentiveness of soils for moisture; hence crops on such soils are less liable to suffer from extreme heat than those on less retentive land. My former determinations of this factor in the soils of Mississippi amply illustrate this point, and California as well as Hawaiian soils [some of the latter contain as much as 39·2 per cent. of ferric-hydrate, corresponding to 27·4 per cent. of metallic iron] confirm the conclusion. A point of practical importance is that, doubtless in consequence of reductive processes,

soils very rich in ferric-hydrate suffer more promptly and severely from lack of drainage than similar soils of low iron percentage.

Phosphoric Acid.—The conviction that has gradually established itself that the practical values of the several calcic phosphates are not nearly as different as was at first assumed has materially increased the interest of phosphoric acid determination in soils, particularly when these are strongly calcareous, and therefore, according to the well-known play of affinities, most of the phosphoric acid present will be in the form of a tri-calcic phosphate. There is a good reason why less phosphoric acid in a soil will suffice in soils rich in lime than in those in which there is no base ready to dispute the possession of the acid with ferric oxide and alumina which render it relatively insoluble and inert. The very minute amount of phosphates present in the best of soils will render the search of the roots for them very laborious, unless it can be conveyed to them in solution, independently of the acids the roots may secrete. From the discussion of the upland loam soils of the South-Western States, I have been led to consider ·05 per cent. of P_2O_5 as the least amount that can be considered adequate for profitable production in their case, and that the percentage should rise to ·10 per cent. to be satisfactory. But in calcareous and also in very sandy soils of great depth a smaller amount suffices, and in California (where nearly all soils are calcareous) the percentage does not very often exceed ·10 per cent. even in soils of great present productiveness and durability.

Humus.—The determination of humus by Grandeau's method is of the highest interest, as against the extraction with potassic or sodic hydrates, which is still sometimes recommended. As the latter solvents do not discriminate between the crude, unhumified vegetable matter and the active humus, it misses the main point of interest. What degree of uniformity can be predicted of the composition of humus in virgin soils I have not had time to determine. Even the physical properties of the ammoniacal solution obtained vary greatly; yet, as in any case humus must be considered the repository and store-house of the nitrogen supply of soils, its proportion is of high interest. In the loam (oak) uplands of the cotton States the percentage of humus seems to range usually between ·70 and ·80 per cent., in the poorer sandy pine soils between ·40 and ·50 per cent., in the black calcareous prairie soils from 1·20 to 2·80 per cent. The determinations made there are not, perhaps, sufficiently numerous to give fair averages. In California and in the arid region generally the humus percentages, as might be foreseen, average somewhat lower; lowest in light loam soils of the high *mesas* of Southern

California, where ·30 per cent. and even less has been found; yet these soils produce well at first when irrigated. Percentages of ·45 to ·60 of humus are common in good upland loam soils that are neither very calcareous nor highly ferruginous. The "prairie" or black adobe soils usually range from 1·20 to 1·80 per cent., a very few as high as 3·00. On the whole, the highly ferruginous soils are remarkable for large amounts of humus, as in the red soils of foot (?) hills and of the Coast Range. In these latter cases, however, the ammoniacal solution is usually quite light-coloured, and only becomes dark on evaporation, doubtless by oxidation. It is pointedly claimed in some of the fruit-growing regions of the State that a too clean cultivation, entirely suppressing the growth of weeds, and thus affording no annual addition of vegetable matter save from the fall of the leaves, tends to injure the production of the orchards. It is readily conceivable that the long, dry, and hot season would tend to cause a very rapid oxidation of the humus in the soil well tilled, amounting to deprivation when only a very little is originally present. From experience had in green-manuring, it seems that half of 1 per cent. (·50) is the minimum of humus desirable in California, and that when less is originally present an increase should be brought about as soon as possible. In Western Oregon and on Puget Sound, where the summer rainfall is very heavy, humus percentages ranging from 3 to 6 per cent. are quite common. —*Farmer's Review.*

APPLICATION OF LIME TO CROPS.—*Liming.*—The height of summer is often selected as a fitting time for carting lime into land. A slack time occurs in some districts, where hay-making is limited to a small area, between hay-time and harvest, or between turnip-time and harvest. This is, in fact, the farmer's holiday. It is the period for agricultural shows, and such a period of low pressure in work is taken advantage of for carting lime. It falls between the longest day and wheat harvest, and in some localities it does not occur at all, as hay harvest and corn harvest follow each other without any interlude. Liming is understood to mean the application of burnt and calcined lime to the soil, and must not be confused with chalking and marling, both of which operations might also be spoken of as liming land. It is a durable improvement, often undertaken at the commencement of a fifteen or twenty-one years' lease, at the time when such agreements were possible. We seldom now hear of such tenancies, and imagine that they have become things of the past. In these times of uncertainty we may

well ask with the poet, "who can so forecast the years," and see "the far off interest" of his labours? Better a yearly tenancy in these times with the landlord open to reason than a lease which places the farmer at the mercy of the solicitor or the agent. Liming is found beneficial to the following classes of soil, which we shall consider *seriatim*—(1) soils naturally deficient in lime, (2) soils containing an excess of vegetable matter, (3) clay soils, (4) unhealthy, or, more properly, unwholesome soils.

Soils deficient in lime.—Barren soils are often deficient in lime, and there is no more common cause of sterility. The deficiency may be natural to, or inherent in, the soil, and in many cases lime was once present, but has been washed away by rain. Vegetable soils are often deficient in lime. Such soils are generally charged with carbonic acid gas, which enters into combination with lime, converting it into a soluble bi-carbonate, which is carried into the deeper layers, and there deposited as a lime pan. The Cheddar caverns offer an excellent example of this. The roofs and floors are covered with stalactites and stalagmites which owe their origin to the dissolving out of lime from the soil and rocks above. As the water emerges on the roof of the cave, it parts with one molecule or atom of carbonic acid, and the carbonate of lime precipitates and forms a beautiful crust of stalactite, which often assumes grotesque forms and renders the cavern attractive to sight-seers. Pastures resting upon limestone rock are occasionally found deficient in lime from a similar cause. Fertile soils of calcareous character may contain a large portion of lime, and it is possible to find a preponderating proportion of this constituent. Five per cent. of lime is not uncommon, and in analyses of fertile soils before us we note respectively 3·25 per cent. of carbonate of lime and 1·34 and 2·27 per cent. of lime. In barren soils we note ·001 and ·55 per cent. of lime, but in the latter case there is 9·44 per cent. of vegetable matter, so that barrenness is evidently due to a general deficiency of mineral matter. Soils in which lime only exists as a trace can scarcely be fertile, and we should say that 1 per cent. is about as small a proportion as ought to exist. When a soil is found to contain no lime it will require an application of 35,000 lbs., or 12 tons per acre to produce the percentage named as advisable. It might, however, be held that a half per cent. of lime only is necessary, and hence a dressing of 6 tons per acre to soils absolutely wanting in lime might be attended with satisfactory results. These figures are made on the assumption that a soil 9 inches in depth weighs 1,200 tons per acre. It will therefore be seen that want of lime in a soil is not an insuperable obstacle to its cultivation, and

by no means a serious deprivation, as would be absence of potash or phosphoric acid.

Soils containing an excess of vegetable matter are often deficient in lime from causes already given. They are often sour in character owing to free vegetable acids which would readily combine with lime, and thus be rendered innocuous. All fertile soils are alkaline in their reaction, and in them free acids cannot exist. It is simple nonsense to talk of free acids exuding from clover roots and rendering the soil sour, as such acids would be instantly neutralised in any soil capable of growing clover. Peaty soils are, however, often acid, and when so are barren. One of the first steps in reclaiming them is to add lime as well as clay, where possible, but in the present state of agriculture few capitalists would place their money in such a speculative venture. Newly broken up soils, from permanent pasture or heath, should always be limed, and in no circumstance would we be more likely to reap the benefits of such an application.

Clay soils derive a double benefit, first, because their close texture is opened and rendered more easily workable by an application of lime, and, secondly, on account of the direct addition of a valuable plant-food. Lime is also said to re-act upon the mineral matter in the soil, and to render it available for growing plants. On no class of soils is liming more widely practised or more highly valued than upon these.

Unwholesome soils.—Sour soils are unwholesome for the growth of crops. In other cases soils are found to be infested with slugs, other worms, ants, millipedes, and many other pests, and upon them lime exerts an excellent effect, by destroying them. It is one of the best checks to an undue development of insect life, and nothing is better for this purpose than a liberal use of hot lime, worked in during July or August. When land is observed to produce an unhealthy growth, such as clubbed cabbages or turnips, the best cure is lime. If potatoes are affected with a rough or scabby skin, the same treatment will produce clean-skinned potatoes. If clover fails, liming is an excellent remedy, although its application should not be relied upon as a preventative for the occult disease known as clover sickness. We have, as a rule, noticed that clover sickness is not a prevalent evil on chalk soils where lime occurs in abundance. Sour pastures are greatly benefited by lime, and the result of its application is a fine and sweet herbage. These are the principal cases in which liming is beneficial. There is, however, another side to the picture, for we have known too frequent a use of lime to produce an injurious effect upon land.

When liming is injurious.—Over-liming exhausts soils. This is simply a case of special manuring. If lime is relied upon exclusively, we may naturally expect that other constituents will gradually become wanting. Repeated liming will tend to produce a deficiency of potash and sulphates, or of phosphates. Just as repeated dressings of nitrate of soda whip out the available mineral food, so repeated dressings of lime whip out the nitrogenous and remaining mineral constituents not contained in lime. To rely too much on any one fertilizer is bad farming, and a rotation of manures is as important as a rotation of crops. Fortunately, when good farming is carried out no such evil effects are likely to occur. Dressings of lime are then alternated with dressings of dung, and applications of phosphates, possibly of potash, so that the balance of plant-food is maintained at the proper level in the soil. As bad farming is not yet a lost art, landlords and agents are justified in checking any tendency to over-liming; but advice is more needed than prohibition, and if farmers who incline too much to liming were shown the evils of the system, they would probably abandon it.

The best method of liming land.—There are several modes of supplying lime. The most convenient is that of drawing the shells or burnt fragments, and placing them in small heaps, say about eight from each cart-load, in the same manner as dung is drawn out previous to spreading. The little heaps should be covered with a few shovelfuls of earth to protect them from rain, and they will slake into a powdery mass in a few days. When this has been accomplished the heaps are spread with a shovel, taking care that the bottoms of the heaps are scattered abroad. This method saves all the discomfort of spreading from large heaps by loading the slaked lime into carts. It may be recommended at least on arable land, but on grass land the more troublesome system of collecting in large heaps and afterwards spreading slaked lime is necessary. The small heaps, which may be made with impunity upon arable land, would destroy grass, and hence the small heap system is not applicable to grass land.

Quantity.—We consider three tons per acre to be a light but effective dressing of hot lime. Six tons are a good dressing when land is deficient in lime, and we have known nine tons used per acre. Between these limits practice has fixed the quantities of lime usually employed.—*Agricultural Gazette.*

PLANTS AND PHOSPHATES.—An interesting paper on the analysis

of soils by means of plants was recently communicated to the *Académie des Sciences*, Paris, by Prof. George Ville. He shows, for example, that by sowing wheat in a certain soil the proportion of phosphate of lime in the soil can be determined with precision from the nature of the harvest. If the phosphate is absent, the wheat will perish before it flowers. If one centigramme of the salt be placed in a spot of earth the wheat will languish; if two centigrammes it will flourish. Plants which contain phosphates in their seeds, for instance, the common pea, behave in a different way. The seedling will thrive on the phosphate in the seed and itself bear peas, although there is no phosphate in the soil. But if the peas thus grown are again sown in soil without phosphate, the plant will die away, as in the case of wheat of the first generation.—*Indian Agriculturist.*

DIFFERENT CAPACITIES OF DIFFERENT PLANTS FOR ABSORBING NUTRITIVE MATTERS PRESENT IN THE SOIL.—I do not consider that artificial manures are very suitable for the growth of garden produce; in other words, if I were going to establish myself as market gardener, I should select a locality where I could obtain a large supply of yard manure at a cheap rate. Bulky manures have great advantages over artificial manures, as they render the land porous and also retentive of moisture; we rarely have any drainage on the wheat experiments where we apply yard manure every year, which proves that the vegetable matter of the manure retains mechanically the rain. I do not consider that it is possible to lay down any fixed rule with regard to the employment of manure containing nitrogen; for instance, nitrate of soda. It is quite certain that upon most soils there is a large excess of available minerals, while the available nitrogen is more or less dependent upon the amount of organic nitrogen that is formed into nitrates each year.

We have found, in the course of our experiments, that plants differ very much in their capacity to pick up minerals from a soil; for instance, about forty years ago turnips ceased to grow upon one of our fields, being unable to obtain phosphates; since then we have grown ten crops of wheat and ten of barley, each one taking up as much phosphates as would have grown a good crop of turnips. The turnips are sown every year before the barley and after the wheat, but they can form no bulb. We know that it is phosphates which the plant requires, as in another part of the field where we use phosphates the turnips can grow very well. The

same difficulty is experienced with regard to potatoes, but not to the same degree. Potatoes have considerable difficulty in obtaining their mineral food from the soil. There is hardly any crop grown in this country that is so highly manured as the potato, and yet the amount of nitrogen or mineral which it carries off is comparatively small. The cereal crops appear to possess greater power of obtaining food from the soil than any other plants. I have had no experience with corn, but I suppose its capacity to collect its food from the soil must be very great. Wheat certainly can take up much phosphates and potash, and the best proof of this is that after fifty years my unmanured wheat crop is very little less than the average crop of the world. It appears to me that profitable employment of nitrates in the States must depend more upon the absence of weeds than on any other circumstance. Weeds seize upon nitrates with the greatest avidity, and owing to this circumstance we frequently see fields injured rather than benefited by an application of nitrates.

In considering what manure to apply to a crop, we must study the character of the crop and its capacity to take manure out of the soil. The cereal crops can generally find a sufficient amount of mineral food in the soil, and therefore an application of nitrate of soda will generally increase the yield, but whether it can be profitably used is quite another question. In our most careful experiments we cannot get back more than one-half of the nitrogen of which we apply in the manure. If we apply 100 pounds of nitrate of soda to a wheat crop, we furnish it with 16 pounds of nitrogen ; 10 bushels of wheat and 1,600 pounds of straw would contain this amount of nitrogen. If a farmer got one-half of this quantity it would pay him very well in this country, as five bushels of wheat would be worth 20*s*. and the manure would cost less than one-half. The farmer is also very glad to get the increased straw.

THE ECONOMIC USES OF LEAVES.—Of the three divisions of Nature's products, man is most chiefly indebted to the vegetable kingdom, whether for his food, medicine, or domestic comforts. Every part of plants and trees is more or less utilised by savage and civilised men, and a common category might be furnished by the various uses of the separate parts—the roots, stems, sap, bark, fruit and seeds, and leaves. If we take the last-named, the foliage, apparently the most insignificant part of the plant, how dependent are we on these for food, clothing, medicine, dyes, stains, and various comforts.

The miscellaneous application of leaves for different purposes as domestic appliances and for manufacturing uses of themselves would furnish a long list: some few of these we may pass under notice, because their adaptability and usefulness are mainly confined to tropical countries. It is true that some leaves have been utilised by the paper-maker, as in those of the dwarf palm, maize leaves, and others, but this is only on a small scale.

The leaves of many palms are largely employed for making hats. Those best known are Panama hats, so named from being shipped from that port. These are made from the finely-plaited fibre of the leaves of a South American Screw-pine (*Carludovica palmata*). These hats are much prized for wear in the tropics, being light and flexible, and can be washed and bleached repeatedly. The tree has no stems, the leaves have long slender petioles, springing from the ground they are some 2 feet long, fan-shaped, and four-parted, each segment being again ten-cleft, so that when folded in venation, each segment on its own rib, there are eighty layers in a young leaf. The tree occurs only on the slopes of the Andes. About 200,000 dozens of these hats are made in Ecuador and the different States of South America. These hats are distinguished from all others by consisting only of a single piece, and by their lightness and flexibility they may be rolled up and put in the pocket without injury. In the rainy season they are apt to get black, but by washing with soap and water, besmearing them with lime-juice or any other acid, and exposing to the sun, their whiteness is easily restored. The plaiting of the hats is very tedious and troublesome, the coarse ones may be finished in two or three days, but the fine ones take as many months to plait. It commences at the crown and finishes at the brim. The hats are made on a block, which is placed upon the knees, and requires to be constantly pressed with the breast. The hats vary in price, according to fineness and quality, from 20*s*. to as many pounds.

The unexpanded fronds of *Livistonia australis*, prepared by being immersed in boiling water, are dried, and the fibre thus obtained is much valued for the manufacture of hats in Australia, which much resemble the celebrated Panama hats.

The rough leaves of the Chumico (*Curetella americana*) and of *Davilla lucida* are used for cleaning iron and polishing and scouring wood. *Curatella alata* is used in the West Indies for polishing bows, sabres, &c.; and *C. Sambaiba* in Brazil—indeed, they serve all the purposes of sand-paper to the Indians for polishing their blow-pipes and war clubs. The leaves of *Sponia politoria* are used for polishing horns in the East Indies.

The foliage of *Guiacum officinale* is very detersive, and is frequently used in the West Indies to scour and whiten floors, which it is said to do better than soap.

Leaves sewn together are much used in India as substitute for the plates and dishes of more civilised life. It is not always poverty that leads natives to use them in preference to metal or porcelain articles, as caste or custom has often some influence in the matter. The leaves principally used are those of the Egyptian Lotus (*Nelumbium speciosum*), Bauhinia species, *Semecarpus Anacardium*, *Butea frondosa:* those of the banyan (*Ficus bengalensis*), by Brahmins, and the plantain-leaf (*Musa paradisaica*).

The leaves of *Bauhinia Vahlii* are used in the construction of the curious rude leaf bellows in Sikkim with which the natives of the hills smelt iron. These leaves, when sown together, are used as plates, cups, rough table cloths, rain hats and caps. The leaves are heart-shaped, and above a foot in breadth, and the same in length. Sewn together with twigs, they also serve for baskets for holding pepper, turmeric, and ginger, and are likewise used for thatching.

Under the name of "chhata," a kind of umbrella, hat, or sunshade is made in the East of the leaves of the *Lacuala peltata* and the Talipot palm, or a plantain leaf. These chhata hats are much worn by the ploughmen, cow-keepers, and coolies of Bengal and Assam.

The large fan-shaped leaves of the Talipot palm (*Corypha flabelliformis*) are like those of the palmyra palm, carried over the heads of people of rank as an umbrella, and are also used for making books, and for various domestic purposes. The leaves are also put up into neat bracelets, worn by Santal girls in India. Those of *Vanda Roxburghii*, split, are also worn by them as anklets. Those of another species, *Borassus æthiopicus*, occur as much as 12 feet across ; they serve also for the manufacture of baskets, mats, ropes, and sieves. The leaves of *Nipa fruticans* attain a height of 15 to 20 feet, presenting a very handsome appearance resembling the fronds of huge ferns. This graceful Eastern palm is utilised in various ways, the principal being in the manufacture of thatching for house-roofs in the East called Ataps ; this manufacture is quite an industry of itself and affords employment to many natives, chiefly women, the men simply bringing cargoes of the fronds to the women to be stitched with split rattans and made up. Atap roofs are the best adapted for these climates, for while the winds are never strong enough to blow them away, they afford the coolest protection against the sun of any kind of roofing known.

The leaves of the palmyra palm (*Borassus flabelliformis*) were formerly used like paper to write books on, and to this day they are applied to this purpose in Orissa, Southern India, and Ceylon, where an iron style is employed to write upon them ; in certain parts of Bengal young children use them to write the alphabet lessons on. They are largely employed for making fans, bags, winnows, hats, umbrellas, and for thatching, &c. The leaf takes a dye well, and is worked up in Madras into pretty-coloured patterns in baskets and mats.

The slips of Talipot and other palm leaves are coming into European commerce for the manufacture of ornamental braids and in the construction of straw or Leghorn hats. The fibre obtained from the base of the leaves of the Chusan palm (*Chamærops Fortunei*) is used by the Chinese for making hats and coarse clothing. The sale of palm leaves for decorative purposes in the town of Elche and Alicante in Spain produces a considerable income to the towns.

Kadjan mats, manufactured out of Nipa leaves, are indispensable for travelling purposes ; packed up in the smallest compass when not required, each mat is capable of affording sufficient cover at night for two or three persons either in boat or forest journeys. They also form almost exclusively the material for side-walls and divisions within houses. The young leaf, unfolded and dried, under the name of Roko, forms the favourite covering for cigarette in the Malayan Peninsula in preference to paper.

The large leaves of the teak tree (*Tectona grandis*) are used for plates, for packing, and for thatching. The leaves of *Cordia Myxa* are employed as plates in Pegu, and to cover Burmese cheroots. In Bangalore the leaves of *Canna indica* are used by the natives in lieu of plates, to serve their ragi or millet puddings and other dishes on.

The leaves of the papaw tree (*Carica Papaya*) are employed by the negroes in washing linen as a substitute for soap. They have also the property of rendering meat wrapped in them tender, owing to the alkaloid *papain* which they contain, and which acts as solvent.

For cordage and other textile purposes, numberless leaves are used, and they serve very generally for baling and wrapping up small parcels in India.

In Guiana, Tibisiri fibre is obtained from the inner surface of the spiral leaves of the Ita palm (*Mauritia flexuosa*); it is used by the Indians for making hammocks, &c. The leaves are cut before they are open, and the midrib separated by drawing each division of the leaf through the finger and thumb. After drying, the fibre

is ready for use without further preparation. About a quarter of a pound may be procured from each leaf, and if the central leaf is left uninjured, no evil effect is produced on the tree. Bags or matting could be cheaply and easily made from this fibre as well as hats, similar to those known as Pamana.

The foregoing is only a brief enumeration of some of the many uses to which leaves are industriously applied.—P. L. SIMMONDS.—*Gardeners' Chronicle.*

MANURES FOR CROPS.—*Potash Manures.*—The quantity of potash in most soils greatly exceeds that of phosphoric acid. Thus while in fertile soil there may be from ·7 to 1·5 of the former, there may be only ·3 to ·5 of the latter. The weight of an acre of arable land 9 inches deep ranges from 3,000,000 lbs. to 3,500,000 lbs., which gives 3,000 lbs. to 3,500 lbs. for every 0·1 per cent. of any constituent. There will therefore be in many soils from 17,500 lbs. to 36,000 lbs. of potash per acre, against from 7,500 lbs. to 12,500 lbs. of phosphoric acid. Clay soils are richer in potash than lighter and sandier soils. This abundance of potash is in itself a reason why potassic manures are less effective than some other fertilisers which contain rarer substances. Another fact in connection with potash is that it is for the most part returned to the soil in the form of straw used for litter or food for stock, so that while phosphoric acid is constantly drained off the farm through sales of wheat, milk, and young animals, most of the potash is retained. Again, farm-yard manure contains about 0·67 per cent. of potash, so that in applying 15 tons of dung we are adding 2 cwt. of pure potash. If farm-yard manure may be viewed as a nitrogenous manure, it may equally well be spoken of as a potassic manure. The drain of potash from land is, however, constant, although slow. To a certain degree it is washed through the soil in natural drainage, and it is also removed by the sale of crops. Before the discovery of the immense beds of kainit which exist in the rock-salt deposits of Stassfurt in Prussia, agricultural chemists looked forward to a time when a potash salts would be in greater demand than were likely to be supplied from existing sources. Potash was then an expensive fertiliser, but since that time and for many years past potash salts have been offered at a reduced price, and are at present quoted at £3 10*s.* per ton ex-ship. Up to the present time the demand has been limited, and it does not occur to the majority of farmers to apply kainit. It is, however, used upon certain light soils which are naturally deficient in potash, and for potatoes, beans,

and clover, on account of the large amount of this alkali which they require. A good sample of kainit contains 25 per cent. of sulphate of potash associated with 30 per cent. of common salt, and about the same proportion of magnesium and lime salts. The remainder is water and insoluble silicious matter. 4 cwt. of kainit, it will be observed, only adds 1 cwt. of sulphate of potash to the land, and a much smaller amount of potash. An ordinary dressing of farm-yard manure would therefore restore as much potash to a field as half a ton of kainit, and this being the case, it does not seem very likely that the demand for potash salts will increase. The amount of potash in soils has already been stated as from 17,000 to 36,000 lbs. per acre. It is not contended that this is all available, although as it is usual only to analyse the fine portions of a soil which pass through a very small mesh, much of it must be attackable by growing roots—the salts of potash being easily soluble.

The following crops are known to absorb large quantities of potash taken from the soil :—

6 tons of potatoes	with their tops	take up	76 lbs.	of potash	per acre.
30 bushels of beans	„ straw	„	81 lbs.	„	„
30 bushels of wheat	„ „	„	28 lbs.	„	„

The astonishing fact is noted that after eight years removal of crops the final crop was rather larger where no potash had been applied than where 500 lbs. of its salts had been annually applied. And yet it would not be wise to conclude that because no effect was produced at Rothamsted that potash salts are therefore not useful. It would be equally foolish to think because a great result would be obtained at Rothamsted we might expect the same anywhere. Each farmer must be an experimentalist for himself, and hitherto we have not seen much evidence of the use of potash salts as manure for ordinary soils, such as we have seen in case of phosphatic and nitrogenous manures. They are most likely to be effective on the lighter classes of land.

Nitrogenous Manures.—The two best known members of this group are nitrate of soda and sulphate of ammonia, and most of the other nitrogenous manures are refuse materials from animal bodies or from seeds. Such are all the guanos, blood, wool, fish and flesh, and cake manures. The efficacy of nitrogenous manures appears to be due to two facts. First, that nitrogen in an available form exists in very small quantities in the soil, and, secondly, that it is required in proportionately large quantities by crops. The total amount in the land may in good fields be taken in the top nine inches as 0·15, or one-tenth of the amount of potash. Nitrogen is

available chiefly in the form of nitrate, and these are much more liable to wash through the soil than are potash salts. Finally nitrogen is removed from the farm in saleable crops and in the bodies of animals in larger quantities than potash, which is largely returned both in root-crops and straw to the land. There may be other reasons, but these sufficiently account for the great effect produced by nitrogenous dressings of all kinds. So rapid is their effect that it has been called "stimulating," although without sufficient reason. The crops seem to hunger for nitrogen, and always present a yellow and starved appearance when it is deficient. A rank dark green appearance always accompanies a full, or overfull, stock of nitrogen in the soil. It is to the grasses, including the cereals, that these manures are most useful. But wherever leafy growth is desired, as in the cultivation of cabbages and rape, nitrogen in the form of nitrates may be applied with success. The leguminous crops, beans, peas, and clover, are not so much benefited by direct dressings, but they require the land to be rich in nitrates notwithstanding. The absolute necessity of nitrates for the cereals has been amply proved. Wheat appears as if it could be grown consecutively for almost any number of years on the same land if only plenty of nitrates are added.

Nitrates, no doubt, if used alone, tend to exhaust the other constituents of plant-food if the produce is sold off the farm. If, on the other hand, the produce is consumed at home, or if foods for stock and other manures are purchased in liberal quantities, there is no fear of exhaustion. So important are they, that sometimes it appears as though the entire science of manuring consists in adding nitrates to the soil. The effect is, however, greatly increased if phosphates, and in some cases other mineral manures, are added with the nitrates, so that heavy as the crops are which may be grown with nitrate of soda, they are eclipsed by a judicious use of nitrates and mineral substances combined. In applying nitrates we prefer to use them in organic combination wherever possible. Nitrate of soda and sulphate of ammonia are both exceedingly useful, but are subject to washing through the soil by rain—the first immediately and the second more gradually, as nitrification proceeds. They act rapidly, but the effect is not seen after the first season. When nitrogen exists in animal or vegetable matter, its action is slower, more uniform, and is continued for an indefinite length of time. Farm-yard manure is an example of this action; so also are rape, cake, and blood manure, shoddy, guano, and many other substances. Such animal refuses can, however, hardly be classed with artificial manures, and we therefore postpone their further consideration.

Salt.—Salt is a cheap material, which may be employed with good effect upon coarse rank pastures, and produces the best effect when mixed with lime. Five hundredweight of salt and three to five tons of lime applied in February or March to such rank grass land tends to produce a finer herbage. Salt may also be used as a dressing for wheat at the rate of about 5 cwt. per acre. Dr. Griffith says salt eradicates couch on land infested with it. If this is the case, we have an additional excellent reason for applying it. It is also a good dilutent for the better distributing of nitrate of soda, and is said to check the disposition to develop too much straw, which has been observed after nitrate of soda on wheat. It is also considered by many persons to strengthen the straw of cereal crops and prevents lodging of the crop before harvest. It also destroys slugs and snails, and is distasteful to insect life generally. It in this respect resembles soot, which is one of the best applications for land affected with these pests.—*Agricultural Gazette.*

Cultivation of Grass Preserves.—Good feeding grass and shelter are the main desiderata in stock rearing, and it is interesting to find Sir James Caird in a review of British agriculture, stating that the experiments of Sir John Bennet Lawes had shown that the natural produce of grass may be doubled and even trebled by the continuous use of special manures. Trials in this direction and in that of growing superior pasturage by irrigation are much needed in India.—*Indian Agriculturist.*

Forest areas of European Countries.—The forests of Europe, according to a recent report of one of the State foresters of Prussia, cover the following areas :—Germany, 34,596,000 acres ; Russia, 494,228,600 acres ; Austria-Hungary, 46,951,700 acres ; Sweden, 42,000,000 acres ; France, 22,240,000 acres ; Spain, 19,769,000 acres ; Italy, 9,884,570 acres ; and England, 2,471,000 acres.—*Indian Agriculturist.*

Caoutchouc from Coal.—The *Bulletin du Musée Commercial* gives currency to a report from an American source that an American has discovered a means of producing by distillation from coal a bituminous substance possessing all the qualities of rubber, and which may be equally well used in the manufacture of submarine cables. The cost of this article is said to be much less than that of vegetable caoutchouc.—*Indian Agriculturist.*

THE ARTIFICIAL PRODUCTION OF SUGAR.—Barely have sixty-two years elapsed since the great German chemist Wohler prepared urea artificially. Up to that date the opinion was generally held that all chemical compounds which are found in the bodies of animals or plants could not be made artificially. They, it was said, are the results of vital action, and the endeavour to prepare them in the laboratory was considered as impossible, and almost as wicked as to try to manufacture an homunculus. Wohler's discovery at once dissipated that false notion, and since his time the labours of chemists have resulted in the manufacture of hundreds of compounds formerly only obtainable by natural processes carried on in living organisms. The latest and perhaps the most remarkable of these triumphs of synthetic chemistry has just been made known to us. The group of bodies termed by chemists the carbo-hydrates—because they are composed of carbon united with oxygen and hydrogen in the proportion in which those two elements combine to form water—contain the well-known series of sugars, gums, and starches. The chemical composition of the bodies has long been known, but a knowledge of their constitution—that is, the mode in which their several constituent parts are put together—has only recently been acquired. It is clear that until we know what is the structure of a complicated arrangement of atoms, it is useless to attempt to build up that arrangement. We must have a plan of the house before we can build it. Such a plan of the structure of the sugars is now in our possession, and their artificial production has therefore become a possibility, and in the hands of a distinguished German chemist, Professor Emil Fischer, of Wurzburg, that possibility has just been converted into a reality. The various steps by which this great result has been accomplished can only be explained and appreciated by those familiar with the intricacies of modern organic chemistry. But the importance of the discovery is patent to all. The group of carbo-hydrates (sugar and starch) are next to the albuminoids (eggs and flesh) the most important materials needed to support animal life. Indeed, the vegetarians would, and perhaps rightly, place them first. Can we look forward to a time when the chemist will manufacture our sugar when the sugarcane and the beetroot will cease to be planted because their products can be more cheaply manufactured from coal or wood? Results apparently as improbable have happened. Who could have foreseen that the thousands of acres upon which the madder-plant grew in France and Turkey would now yield corn and hay, because it was found that the dye formerly obtained from that plant can be more cheaply

made from coal-tar? So, too, indigo has been artificially obtained, and who can tell that a recent new process for its manufacture may not prove fatal to the indigo planter? That the process of making sugar artificially is now too expensive to compete with Nature is, therefore, no proof that cheaper processes will not be discovered; indeed, that this will happen may be taken for granted. So that, looking back to the enormous strides which chemistry has made during the last half-century, and seeing what has already been accomplished, he would be a bold man who should dare to define the limits of her power, or to declare that our grandchildren may not use artificial sugar to sweeten their tea, and that Jamaica may know the sugarcane no more. From a biological point of view, too, this discovery is of deep interest and importance. We know nothing, or as good as nothing, of the processes by which sugar is produced in the plant, nor how this sugar is transformed into starch, fat, and woody fibre. Are these results due to a special vital force, or does this expression merely serve as a cloak for our ignorance, and will careful investigation show that these substances are built up in the plant by methods similar to those which are now successfully employed in our laboratories? That this latter is the true view is the belief of the chemist, and nearer towards that end the discovery of Fischer has undoubtedly brought us.

An interesting physiological question now presents itself. Supposing that these artificial sugars were to become articles of common diet, what will be their effect on the animal economy; that two chemical compounds may possess the same composition and even the same chemical arrangement of their parts and yet act differently from a physiological point of view is well-known. And still more likely will this be if the artificial sugar differs in composition from the natural one. The blood and tissue which are formed from the artificial carbo-hydrates may differ from those which are the results of the assimilation of the natural sugars. If the pig and the goose were fattened on an artificial diet, their fat might differ from that which they now form, and the bee fed on a manufactured sugar might yield another kind of wax. But we may go one step further. We know that plants not only convert sugar into fat, starch, and woody fibre, but that in presence of certain minute organisms they form nitrogenous or albuminoid compounds such as the gluten of wheat. Supposing it were possible to feed plants or these minute organisms on artificial sugars, differing in their properties from their ordinary food, it might force the plant to manufacture a new kind of albumen. And then

what new structures might not be expected to start up from the use of the new building material?

Chemistry would then, for the first time, bring her potent influence to bear upon the structure of organised beings, and the changes of form which would result might prove to be of the strangest and most unexpected kind—changes far more remarkable than all those, singular and far-reaching though they be, caused by processess of artificial selection or of cross-breeding. The revelations of science have already outstripped the marvellous. What yet remains concealed in her bosom defies the wit of man to foretell.—*Sir Henry Roscoe.*

True Theory of Dew.—Until about four years ago, Mr. McPherson says, the theory commonly accepted by scientific men was that which was put forward with a great deal of force by Dr. Wells, in 1814, to the effect that dew was the vapour of the atmosphere condensed on any surface from which there had been radiation sufficient to reduce its temperature below the dew point. Mr. Aitken was led to challenge this conclusion by observing that the temperature of the earth a little below the surface was always warmer than the air above it, whence he concluded that vapour must rise from the earth into the air, and that the moist air so formed will mingle with the air above it, its moisture being condensed into dew wherever it comes into contact with a surface cooled below dew-point. By experiment he found that when shallow boxes were placed over the dry ground in August and September there was always more moisture inside them at night than outside, and always a greater deposit of dew. He found, too, more dew on the undersurface of leaves than on the upper sides. Again, he found that the earth lost weight during the formation of dew, owing to the loss of vapour. But this is not all, for Mr. Aitken has ascertained that all the charming conceits of the poets relating to glistening dew-drops, which "pearl each bud and leaf," or outvie the diamond in lustre, are based upon a misconception. The drops which appear at the points of blades of grass and the edges of the leaves of plants, he says, are not dew at all, but the watery exudations of plants. This he proved by selecting a small turf and placing a glass receiver over it, leaving it till drops were excreted. Removing the receiver, he dried one of the blades which had a drop upon it, and inserted its tip into a small glass receiver. The open end from this vessel was closed by a very thin plate of metal and cemented to it. In the centre of the plate

was pierced a small opening to admit the tip of the blade, and the opening was then made air-tight by means of an India-rubber solution. After a time, though this blade was entirely isolated, a drop was formed on the tip of the same size as that of the drops found upon the blades under the larger receiver. Hence Mr. Aitken concluded that the drops on all the blades were exuded by the plants, and not extracted from the air. Moreover, the results of his investigations upon this point are alone sufficient to dispose of the contention of Mr. Reeves, that plants do not derive any of their moisture from the soil, and that the sap does not rise from the roots.—*Longman's Magazine.*

WILD RICE.—It is now the season for the wild rice (*Zizania*) to be in seed. Though not abundant in Florida, it is to be found in many localities along the marshy banks of creeks. In general appearance it resembles Indian corn. The seeds are borne on the lower branches of the "tassel," and fall off very readily. The following particulars in regard to this interesting grass are taken from the *Western World*—"One of the indigenous grasses of North America, the seeds of which from time immemorial furnished food for wild fowls and scarcely less wild Indians, has recently come into favourable notice for its valuable qualities. The plant referred to is the wild rice. Long before the advent of white men the Indians were accustomed to push their canoes through the waters of the dense rice swamps, and, pausing under thick clumps, beat the ripened grain into their canoes. In this way large quantities were harvested for times of need. The plant abounds in the lakes and sluggish streams from the middle region to Canada and the North-West; it grows luxuriantly, not only in the low, wet banks, but also on the muddy bottom where the water is several feet deep. Wild rice is an annual that ripens its seed in the fall, dropping them into the water, where they germinate, the young plants reaching the surface during the first half of June. It grows very rapidly in one to eight feet of water, ripens late in August or early in September, and attracts great flocks of wild ducks and other wild fowl to the place. It should be planted in the fall, in the months of September or October, broadcast, from a boat, in two to six feet of water where there is a mud bottom. It has been successfully planted in November and December, but succeeds best when planted earlier. As an attraction for wild fowl it cannot be equalled. A friend writes:—'It brought me more nice meals than if I had butchered the fatted calf.' Near the sea coasts it is

the favourite food of mud-hens and rail-birds of all kinds. In large ponds and lakes it purifies the water and affords a refuge for small fry from the large fish, as well as food in the animalculæ upon its stalks. For planting in fish ponds it is especially desirable, as it is greedily eaten by carp. It also does well along the shores of marshes, and makes a good hay. The stems and leaves are valuable as a forage plant in swamps and inundated lands. Stock of all kinds are fond of it, green or cured. The cows give more milk and the horses grow fat. They eat as freely of it as of young sugar corn. It seems destined to be an article of great value as soon as it becomes generally known. Two crops can be cut of it in the South."—*Indian Agriculturist.*

EFFECTS ON PLANTS OF INSECTICIDES CONTAINING ARSENIC.—Experiments made with arsenites at the Iowa Experiment Station lead to the following conclusions :—1. The oldest leaves are most susceptible to injury from arsenical applications. They often turn yellow and drop without showing the burnt spotted appearance. 2. Dews, and probably direct sunlight, increase the injuries done by the arsenites to foliage. 3. Leaves kept perfectly dry can hardly be injured by the arsenites even when they are applied very abundantly. 4. Applications made in the heat of the day and in the bright sunlight do not injure foliage more than when applied in the cool of the day. 5. The only effect of a heavy rain or dashing shower, following an application of one of the arsenites, is to lessen the injury to foliage. 6. Leaves suffering from a fungous disease are more susceptible to injury than healthy leaves. 7. When freshly mixed and applied, London purple is most, and white arsenic is least, injurious to foliage. 8. White arsenic in solution should not be used upon foliage without first adding lime, Bordeaux mixture, or some other substance to prevent its injurious effects upon foliage. 9. White arsenic, if allowed to stand many days in water before being applied, will do far greater harm to foliage than if applied as soon as mixed. 10. Lime added to London purple or Paris green in water greatly lessens the injury that these poisons would otherwise do to foliage. 11. Lime added to a mixture of white arsenic in water will greatly increase the injury that this poison would otherwise do to foliage. If the arsenic is all in solution, the lime will then lessen the injury, as in case of London purple or Paris green. 12. London purple (Paris green and white arsenic have not yet been tried) can be used, at least eight or ten times as strong, without injury to foliage, if applied

in common Bordeaux mixture instead of water. 13. The arsenites cannot by any ordinary method be successfully mixed in a kerosene emulsion. 14. The arsenites mix readily in rosin compounds, and do not seem to be more injurious to foliage than as ordinarily applied in water. 15. The arsenites in strong soapy mixtures do considerably more harm to foliage than when applied in water only. 16. The arsenites mix readily in carbonate of copper solution, and do not seem to do more harm than when applied in water only. 17. London purple in sulphate of copper solution does vastly more harm than when applied in water only.

LOCUSTS AND PINE LEAVES.—Clouds of red locusts passed over Murree on Saturday afternoon. I was on upper Topa to-day about 12 o'clock, when I noticed large numbers of locusts coming up from the valley of the Jhelum in the direction of Dewal. The main body passed over the neck of land between upper and lower Topa, and settled on the crops on the hillside below Powell's Hotel. The right and left wings settled on the Topa hills. Where I was, the ground was thickly covered, and for some time I watched them carefully. They were drawn up in lines like squadrons of cavalry, and all seemed to prefer feeding off the dry pine fibre instead of the leaves of the trees. Those in the valley beneath were not long left to enjoy the crops in peace, for in a few moments fires were seen burning all along the hillside and the sound of the tom-tom was to be heard on all sides. As I came up the hill these pests rose in a cloud from the fields below, and in the distance looked like a miniature dust-storm. After circling for a time, part of the army went off towards the Lawrence Asylum, but the main body crossed Murree just below the church, and were last seen making off in the direction of Attock, to take part perhaps in the mimic warfare being waged there. The exertion of mounting the hill seemed too much for them, for they alighted on the roofs of the shops and houses.—*Civil and Military Gazette.*

THE QUESTION OF VILLAGE FORESTS.—In the course of a long review on certain proposals for the extension of the forest reservation area in the Cuddapah District the Madras Government remarks :—"The whole question of village forests, of grazing grounds, and of fuel and fodder reserves has recently been under the consideration of Government, and it has been decided, with certain modifications, to apply the system already adopted in the

Bellary District to the remainder of the presidency. The reservation of forests in Cuddapah will accordingly proceed on the same lines, and in the taluks where a large proportion of the available waste is taken under control, special arrangements must be made for meeting the wants of the villagers by relaxing the closure of the reserves. This will be specially necessary in the taluks of Pullumpet, Sidhout, and Cuddapah, where it is proposed to reserve more than 65 per cent. of the unoccupied area, but throughout the district it should be clearly understood that, with the exception of those reserves which contain heavy timber and are intended to be worked for the supply of the timber market, the whole of the reserved area is to be made available for the supply of fuel and fodder, and must therefore be thrown open to the people under proper regulations. The proposed reservation in the three taluks noted above is very extensive, but reserves must be constituted in places where suitable land can be found, and if a larger area is set apart in one taluk than in another, the people of the former will eventually reap the benefit by having a better supply of fuel and fodder assured to them. The wants of taluks where the natural jungle growth is scanty must be met from those localities in which land worth conserving is to be found, and also by the formation of Government plantations."

WHOLESALE DESTRUCTION OF FISH IN MADRAS.—Colonel Campbell Walker, Conservator of Forests, Southern Circle, recently brought to the notice of Government the wholesale destruction of fish in rivers. In the Bhavani River the main and subsidiary streams are dammed up and the fish destroyed by dynamite, or the water baled out and fish both large and small taken, and sent into Mettupalayam in bullock and cart loads, and as a similar practice is followed in almost all rivers, it would ultimately tend to the extermination of fish in the rivers of Southern India, as by the above system both fish and fry are destroyed. It is under contemplation to alter the rule in the Madras Forests Act, which permits "the catching of fish by the damming or baling of water" by a proviso that "the Collector may attach such conditions to the issue of the permit as he may consider necessary." This would only affect fish in rivers running through reserved forests, and it is incumbent on Government to adopt some legal measures to regulate the wanton destruction of fish and fry, such as their capture only by the net and rod, the meshes of the former being regulated to such a size that fry may not be taken. A few years

ago Mr. H. S. Thomas, F.L.S., F.Z.S., Member of the Board of Revenue, in charge of the portfolio of Pisciculture, brought the above facts to the notice of Government, but apparently no steps were taken to remedy the evil.—*Indian Agriculturist.*

PLANTS FOR BINDING DRIFTING SANDS.—A correspondent, whose letter we inserted yesterday, writing on "Tree planting in Ganjam" stated that an excellent work in the matter of planting was being carried out by the Local Fund Board of Ganjam under the supervision of the overseer of Chicacole. "Upwards of fifty acres of casuarina have been planted on the drifting sands of the Vamsadhara near Maripam. The wind has forced the sand into dunes, and it is constantly invading the high road—in fact near the river the road is completely obliterated. The planting has been carefully done; each individual plant is manured, and those on the steep sides of the dunes are turfed round. If the plantations succeed they will amply serve their purpose, and not only protect the road but the field behind them and the canal distributaries." Another way of overcoming the effects of drifting sand would be by planting lupins, which have been proved most effective for the purpose. In Australia drift-sand is often very destructive to farms and pastures near the borders of rivers, and many thousands of acres have been rendered useless by the driving showers of grit which assail and cut all kinds of vegetation. Mr. Bundey, of East Wellington, writing to the Commissioner of Crown Lands last October, said that he had sown lupins with this view for fourteen years, and in no case had he to sow the land a second time. He had reclaimed 100 acres of the worst land from the fearful cutting of the drift-sand. When grass begins to grow between the plants, he lets the seeds fall naturally upon the land, and the result is that after the second year sheep can be put upon the pastures.—*Madras Mail.*

DEVULCANISING INDIA-RUBBER.—A. M. Morellett has made a discovery which is of considerable importance to those engaged in the rubber trade. He has found that when vulcanised india-rubber is dipped suddenly into boiling glycerine it acquires the character of non-vulcanised rubber—*i. e.*, its parts can be readily united, and it dissolves in the common solvents of caoutchouc. The glycerine must be boiling at the moment of contact.

VI. EXTRACTS FROM OFFICIAL GAZETTES.

1.—GAZETTE OF INDIA—

No. 1069.—*The 23rd December, 1890.*—With reference to the Notification of this Department, No. 941 F., dated 14th ultimo, *Major C. T. Bingham*, R.E., Officiating Conservator of Forests, 3rd grade, resumed charge of the Tenasserim Circle, Burma, from *Mr. P. J. Carter*, Officiating Conservator, 3rd grade, Pegu Circle, on the 24th November, 1890.

2.—MADRAS GAZETTE—

No. 1.—*The 5th January, 1891.*—*Mr. R. W. Morgan*, District Forest Officer, North Coimbatore, to be District Forest Officer, Nilgiris.

No. 2.—*Mr. T. Sheffield*, District Forest Officer, North Arcot, and Acting District Forest Officer, Nilgiris, to act as District Forest Officer, North Coimbatore.

No. 3.—*Messrs. Horace B. Bryant* and *F. Foulkes*, Trained Forest Officers appointed by Her Majesty's Secretary of State, having reported their arrival in Madras on the forenoon of the 27th December, 1890, are brought upon the strength of the Madras Forest Department as Assistant Conservators, 3rd grade, with effect from that date.

The 17th January, 1891.—*M. Rama Rao*, Ranger, 5th class, is transferred from North Coimbatore to South Arcot, as a temporary measure.

No. 11.—*The 19th January, 1891.*—*Mr. A. W. Peet*, Acting Conservator of Forests, Northern Circle, is granted furlough for fifteen months with effect from 15th February, 1891, under Article 340 of the Civil Service Regulations.

No. 16.—*The 23rd January, 1891.*—*Mr. Richard McIntosh*, one of the Trained Forest Officers appointed by Her Majesty's Secretary of State for India, having reported his arrival in Madras on the 14th January, 1891, is brought upon the strength of the Madras Forest Department as Assistant Conservator, 3rd grade, with effect from that date.

No. 17.—In modification of Government Notification No. 200, published at page 504, Part I., of the *Fort St. George Gazette* of 31st July, 1885, the Right Honorable the Governor in Council is pleased to appoint *M. R. Ry. C. Somasundara Sastriar Avargal* to be Forest Settlement Officer for the following blocks in the Adoni Taluk of the Bellary District:—

1. Tungabhadra.
2. East Adoni.
3. West Adoni.

4th February, 1891.—The leave on medical certificate granted to Forest Ranger *M. Rama Rao*, and notified at page 1622, Part II, of the *Fort St. George Gazette* of 16th December, 1890, is extended to 24th January, 1891, inclusive, to enable him to join in South Arcot, to which district he has been transferred.

No. 32.—*The 10th February, 1891.—Mr. H. T. D. Sweet*, Assistant Conservator of Forests, 2nd grade, has been granted by the Right Honorable the Secretary of State for India six months' extraordinary leave on medical certificate without pay in continuation of the leave notified on page 538 of Part I. of the *Fort St. George Gazette*, dated 5th August, 1890.

No. 33.—*Mr. C. Somers-Smith*, Assistant Conservator of Forests, Madras, has been granted by the Right Honorable the Secretary of State for India an extension of three months' extraordinary leave on medical certificate without pay in continuation of the leave notified on page 1073, Part I., of the *Fort St. George Gazette*, dated 19th December, 1890.

No. 42.—*The 16th February, 1891.—Mr. C. E. Brasier*, District Forest Officer, Tinnevelly, is granted furlough for six months from or after the 11th April, 1891, under Article 340 (*b*) of the Civil Service Regulations.

No. 43.—*The 17th February, 1891.—Mr. A. W. Peet*, Acting Conservator of Forests, Northern Circle, is granted furlough for fifteen months with effect from the 31st March, 1891, under Article 340 of the Civil Service Regulations. This cancels Notification No. 11, published at page 41, Part I., of the *Fort St. George Gazette*, dated 20th January, 1891.

No. 45.—*Mr. E. D. M. Hooper*, District Forest Officer, Bellary, to act as District Forest Officer, Godavari.

No. 46.—*Mr. A. B. Jackson*, Assistant Conservator of Forests attached to Cuddapah District, to act as District Forest Officer, Bellary.

3.—BOMBAY GAZETTE—

The 19th December, 1890.—Messrs. H. Murray and *A. Stewart*, Deputy Conservators of Forests, respectively delivered over and received charge of the Northern Forest Division of Kánara on the 12th instant, before noon.

The 22nd December, 1890.—Messrs. A. Stewart, Deputy Conservator of Forests, 4th grade, and *G. P. Millett*, Acting Deputy Conservator of Forests, 4th grade, respectively delivered over and received charge of the office of the Divisional Forest Officer, South Thána, on the 9th December, 1890, before office hours.

The 10th January, 1891.—Mr. B. G. Deshpande, who was appointed to act as Sub-Assistant Conservator in Government Resolution No. 8906, of the 12th December, 1890, reported himself for duty on the 18th ultimo, after office hours.

No. 339.—*The 14th January, 1891.—Mr. N. D. Satárávála*, Sub-

Assistant Conservator of Forests, Working Plans Party, Kánara, passed an examination in Kánarese on the 12th instant.

Mr. C. M. Hodgson, Assistant Conservator of Forests, who was posted to the Southern Circle in Government Resolution No. 9282, of the 31st December, 1890, arrived in Bombay and reported himself for duty on the afternoon of the 29th ultimo.

No. 675.—*The 27th January, 1891.—Mr. W. R. Woodrow*, Deputy Conservator of Forests, 4th grade, and Divisional Forest Officer, Southern Division of Kánara, is allowed privilege leave of absence for three months from 10th February, 1891, or from such subsequent date as he may avail himself of it.

No. 755.—*The 28th January, 1891.*—His Excellency the Governor in Council is pleased to make the following arrangements during the absence of *Mr. W. R. Woodrow* on privilege leave or pending further orders:—

Mr. A. Stewart to do duty as Divisional Forest Officer, South Kánara.

Mr. H. Murray to do duty as Divisional Forest Officer, North Kánara, in addition to his own duties, pending the return of *Mr. W. A. Talbot* from leave.

Mr. L. S. Osmaston, Assistant Conservator of Forests, who was attached to the Northern Circle (*vide* Government Resolution No. 9282, of the 31st December, 1890, in the Revenue Department) arrived in Bombay and reported himself for duty on the afternoon of the 29th ultimo; and being subsequently posted to the South Thána Division for duty reported himself, before office hours, on the 12th January, 1891, at Thána to the Divisional Forest Officer.

Messrs. J. H. Clabby, Sub-Assistant Conservator of Forests, and *L. S. Osmaston*, Assistant Conservator of Forests, respectively delivered over and received charge of the South Sub-division Forest Office, South Thána, on the 16th instant, after office hours.

The 14th February, 1891.—Mr. A. Stewart, Deputy Conservator, delivered over, and *Mr. H. Murray*, Deputy Conservator, received charge of the Northern Division of Kánara on the 9th instant, before office hours.

Mr. W. R. Woodrow, Deputy Conservator, delivered over charge of the Southern Division of Kánara to *Mr. A. Stewart* on the forenoon of the 10th instant.

4.—CALCUTTA GAZETTE—

The 10th January, 1891.—Mr. H. H. Davis, Deputy Conservator of Forests, in charge of the Darjeeling Forest Division and of the Darjeeling Sub-division, will hold charge of the Teesta Sub-division in addition to his other duties.

Mr. E. J. N. James, Sub-Assistant Conservator of Forests, in charge of the Teesta Sub-division, on being relieved by *Mr. Davis*, is attached to the Sunderbuns Forest Division.

The 13th January, 1891.—Mr. R. L. Heinig, Assistant Conservator of Forests, 1st grade, having assumed charge of the Chittagong

Forest Division on return from the three months' privilege leave (granted him in Notification, dated 14th August, 1890) on the afternoon of 19th November, 1890, *Mr. H. H. Haines*, Officiating Assistant Conservator of Forests, 1st grade, reverted to his substantive appointment of Assistant Conservator of Forests, 2nd grade, with effect from the 20th idem.

The 24th January, 1891.—The leave on medical certificate granted to *Mr. M. S. Fowler*, Deputy Conservator of Forests, in the Notification of this Department, dated the 16th December, 1890, is hereby extended by one month.

The 27th January, 1891.—*Mr. F. C. Heavey*, who has been appointed by Her Majesty's Secretary of State for India to the Forest Department in Bengal, and who reported his arrival in Calcutta on the 29th December, 1890, is appointed to be an Assistant Conservator of Forests of the 3rd grade, and is posted to the Working Plans Division. *Mr. Heavey* joined the Working Plans Division on the afternoon of the 6th January, 1891.

The 27th January, 1891.—Consequent on the grant of six weeks' sick leave on medical certificate to *Mr. M. S. Fowler*, Deputy Conservator of Forests, the following temporary promotions are made, with effect from the 3rd December, 1890, and until further orders:—

Mr. R. L. Heinig, Assistant Conservator of Forests, 1st grade, to officiate in the 4th grade of Deputy Conservators.

Mr H. H. Haines, Assistant Conservator of Forests, 2nd grade, to officiate in the 1st grade of Assistant Conservators.

5.—North-Western Provinces and Oudh Gazette—

No. $\frac{6025}{\text{II-309B-4}}$.—*The 24th December, 1890.—Colonel J. E. Campbell*, Deputy Conservator of Forests, 1st grade, on return from furlough, to the charge of the Garhwál Forest Division.

No. $\frac{6028}{\text{II-309B-7}}$.—*Mr. B. B. Osmaston*, Officiating Deputy Conservator of Forests, on being relieved of the charge of the Garhwál Forest Division by *Colonel J. E. Campbell*, to be on special duty in connection with the preparation of Working Plans in the Central Circle.

No. $\frac{307}{\text{II-456A-53}}$.—*The 27th January, 1891.—Mr. A. G. Hobart-Hampden*, Officiating Deputy Conservator of Forests, on return from leave resumed charge of the Kumaun Forest Division on the forenoon of the 27th October, 1890.

No. $\frac{389}{\text{II-721B-25}}$.—*The 30th January, 1891.—Mr. J. M. Blanchfield*, Sub-Assistant Conservator of Forests, from the Garhwál Forest Division to the Bundelkhand Forests, with effect from the 4th December, 1890.

No. $\frac{462}{\text{II-748A-19}}$.—*The 6th February, 1891.*—With effect from the 18th November, 1890, the date on which *Colonel J. E. Campbell*, Deputy Conservator of Forests, 2nd grade, was promoted to the 1st grade:—

Mr. W. Shakespear, Deputy Conservator of Forests, 3rd grade, to be Deputy Conservator of Forests, 2nd grade.

Mr. S. Eardley-Wilmot, Deputy Conservator of Forests, 4th grade, to be Deputy Conservator of Forests, 3rd grade, but to continue to officiate as Conservator of Forests, 3rd grade.

Mr. F. B. Bryant, Assistant Conservator of Forests, 1st grade, to be Deputy Conservator of Forests, 4th grade, but to continue to officiate as Deputy Conservator, 3rd grade.

Mr. L. Mercer, Assistant Conservator of Forests, 2nd grade, to be Assistant Conservator of Forests, 1st grade, but to continue to officiate as Deputy Conservator of Forests, 4th grade.

No. $\frac{851}{\text{VI.-16B-285}}$.—*The 10th February, 1891.*—Under Section 14 of Act X. of 1882, *Pandit Raghubar Dayal Bajpai*, Superintendent, Bahramghát Timber Depôt, Bara Banki District, is invested with the powers of a Magistrate of the 3rd class for the trial of such cases arising in Pargana Rámnagar, Bara Banki District, as may be entrusted to him by the District Magistrate.

No. $\frac{121}{\text{VII.-274B}}$.—*The 12th February, 1891.*—The Hon'ble the Lieutenant-Governor and Chief Commissioner is pleased to declare the undermentioned gentleman to have passed the Departmental Examination of Junior Officer, held on the 28th October, 1890, and following days, in the subjects and by the standards specified below:—

Forest Law by the Higher Standard.

Mr. A. P. Grenfell, Assistant Conservator.

6.—PUNJAB GAZETTE—

No. 559.—*The 24th December, 1890.*—*Mr. A. V. Monro*, Assistant Conservator of Forests, 2nd grade, is promoted to officiate as Assistant Conservator of Forests, 1st grade, with effect from 29th October, 1890.

No. 1.—*The 6th January, 1891.*—*Messrs. A. V. Monro*, Assistant Conservator of Forests, and *A. E. Wild*, Deputy Conservator of Forests, respectively made over and received charge of the Hazára Forest Division on the afternoon of the 20th December, 1890.

No. 5.—Consequent on the departure on the afternoon of the 25th November, 1890, of *Messrs. J. H. Lace* and *A. L. McIntire*, Deputy Conservator of Forests, 4th grade, and Officiating Deputy Conservator of Forests, 4th grade, respectively, on the privilege leave granted in Punjab Government Notifications Nos. 525 and 531, dated 6th December, 1890, His Honor the Lieutenant-Governor is pleased to sanction the following temporary promotions, to take place with effect from the 26th November, 1890, until further orders:—

Messrs. E. R. Murray and *G. S. Hart*, from Assistant Conservator of Forests, 1st grade, sub. *pro tem.*, to officiate as Deputy Conservator of Forests, 4th grade.

Mr. A. V. Monro, from Officiating Assistant Conservator of Forests, 1st grade, to Assistant Conservator of Forests, 1st grade, sub. *pro tem.*

No. 30.—*The 21st January, 1891.*—*Messrs, J. L. Pigot*, Deputy Conservator of Forests, and *A. V. Monro*, Assistant Conservator of Forests, respectively made over and assumed charge of the Kulu Forest Division on the afternoon of the 5th January, 1891, on the departure of the former on the three months' privilege leave granted in *Punjab Government Gazette* Notification No. 536, dated 9th December, 1890.

No. 33.—His Honor the Lieutenant-Governor is pleased to make the following temporary promotion with effect from the 22nd of December, 1890:—

Mr. J. E. Barrett, Assistant Conservator of Forests, 2nd grade, to officiate as Assistant Conservator of Forests, 1st grade.

No. 50.—*The 3rd February, 1891.*—*Mr. R. H. C. Whittall*, Conservator of Forests, Punjab, is granted furlough out of India for one year, under Article 310 (*b*) of the Civil Service Regulations, with effect from the 10th March, 1891, or such subsequent date as he may avail himself of it.

No. 55.—*The 6th February, 1891.*—Gazette Notification No. 552, dated 15th December, 1890, is hereby declared to be cancelled in so far as it concerns the promotion of *Mr. Smith* and the reversion of *Mr. Lace.*

No. 63.—*The 18th February, 1891.*—Consequent on the departure of *Mr. J. L. Pigot*, Deputy Conservator of Forests, 4th grade, sub. *pro tem.*, on the three months' privilege leave granted in Punjab Government Notification No. 536, dated 9th December, 1890, His Honor the Lieutenant-Governor is pleased to make the following temporary and sub. *pro tem.* promotions with effect from the 6th January, 1891:—

Mr. R. J. P. Pinder, Officiating Deputy Conservator of Forests, 4th grade, to be Deputy Conservator of Forests, 4th grade, sub. *pro tem.*

Mr. G. S. Hart, Assistant Conservator of Forests, 1st grade, sub. *pro tem.*, to be Officiating Deputy Conservator of Forests, 4th grade.

Mr. J. E. Barrett, Officiating Assistant Conservator of Forests, 1st grade, to be Assistant Conservator of Forests, 1st grade, sub. *pro tem.*

No. 66—In continuation of *Punjab Gazette* Notification No. 5, dated 6th January, 1891, His Honor the Lieutenant-Governor directs the following temporary promotion to take effect from the 26th November, 1890:—

Mr. L. Gisborne Smith, Deputy Conservator of Forests, 4th grade, to officiate as Deputy Conservator of Forests, 3rd grade.

No. 67.—Consequent on the return from privilege leave of *Mr. R. H. C. Whittall*, Conservator of Forests, Punjab, *Mr. L. Gisborne Smith*, Officiating Deputy Conservator of Forests, 3rd grade, reverted to Deputy Conservator of Forests, 4th grade, with effect from the 11th December, 1890.

7.—CENTRAL PROVINCES GAZETTE—

No. 8085.—*The 24th December, 1890.*—The following officers of the

Forest Department have passed the prescribed Examination in Hindustani, by the Higher Standard :—

Mr. A. W. Blunt.
Mr. M. Muttannah.
Mr. P. H. Clutterbuck.

No. 8086.—With reference to Notification No. 6390, dated the 10th October last, *Mr. F. C. Hicks*, Assistant Conservator of Forests, assumed charge of his duties at Jubbulpore on the afternoon of the 3rd ultimo.

No. 8137 —*The 31st December, 1890.*—With reference to Notification No. 7165, dated the 11th November, 1890, *Mr. A. M. Caccia*, Assistant Conservator of Forests, assumed charge of his duties in the Hoshangabad Forest Division on the afternoon of the 23rd idem.

No. 249.—*The 15th January, 1891.*—The following officer of the Forest Department has passed the Examination in Revenue and Forest Law :—

Mr. A. M. Caccia, Assistant Conservator of Forests.

No. 131.—*The 6th February, 1891.*—*Mr. V. S. Menzies*, who has been appointed by Her Majesty's Secretary of State for India to be an Assistant Conservator of Forests, 3rd grade, and has been posted to the Central Provinces, reported his arrival at Nagpur on the forenoon of the 2nd instant.

Mr. Menzies is posted to the Chanda Forest Division.

No. 833.—*The 11th February, 1891.*—With reference to Notification No. 425, dated the 22nd ultimo, *Mr. E. M. Coventry*, Assistent Conservator of Forests, assumed charge of his duties in the Nimar Forest Division on the afternoon of the 6th idem.

No. 856.—*The 12th February, 1891.*—Furlough to Europe for one year, under Article 371 (*a*) of the Civil Service Regulations, is granted to *Mr. A. A. Watson*, Assistant Conservator of Forests, Nagpur-Wardha Division, with effect from the date on which he is relieved of his duties.

No. 425.—*The 22nd January, 1891.*—*Mr. E. M. Coventry*, who has been appointed by Her Majesty's Secretary of State for India to be an Assistant Conservator of Forests, 3rd grade, reported his arrival at Jubbulpore on the afternoon of the 31st ultimo.

Mr. Coventry is posted to the Nimar Forest Division.

8.—BURMA GAZETTE—

No. 228.—*The 12th December, 1890.*—The undermentioned officer has been granted an extension of leave by Her Majesty's Secretary of State for India :—

Mr. E. P. Popert, Conservator of Forests, six months' leave on medical certificate.

No. 229.—*The 13th December, 1890.*—*Mr. P. J. Carter*, Officiating Conservator of Forests, made over charge of the Tenasserim Circle to *Major C. T. Bingham*, on the 24th November, 1890, before noon.

No. 230.—*The 17th December, 1890.*—The services of *Mr. T. A. Hauxwell*, Deputy Conservator of Forests, are placed at the disposal of the Superintendent of Forest Surveys for employment in

connection with the survey of the forests in the Tenasserim Circle.

No. 28.—With reference to Revenue Department Notification No. 176 (Forests), dated the 23rd October, 1890, *Mr. G. F. R. Blackwell*, Officiating Deputy Conservator of Forests, relinquished charge of the Myadaung Sub-division of the Katha Division on the afternoon of the 8th November, 1890.

No. 23.—*The 29th December, 1890.*—With reference to this office Notification No. 22, dated the 5th December, 1890, published at page 878, Part IV., of the *Burma Gazette* of the 13th instant, *add to the same* "on the afternoon of the 1st instant."

No. 233.—*The 30th December, 1890.*—*Mr. W. A. Hearsey*, Sub-Assistant Conservator of Forests, is posted to the Bhamo Division.

No. 1.—*The 2nd January, 1891.*—*Mr. Joseph Messer*, who has been appointed to be an Assistant Conservator of Forests in Burma, reported his arrival in Rangoon on the 1st January, 1891, before noon.

Mr. Messer is posted to the Pegu Circle.

No. 2.—*Mr. Alfred Maule Burn-Murdoch*, who has been appointed to be an Assistant Conservator of Forests in Burma, reported his arrival in Rangoon on the 1st January, 1891, before noon.

Mr. Burn-Murdoch is posted to the Upper Burma Circle.

No. 3.—*Mr. Henry Hughes Forteath*, who has been appointed to be an Assistant Conservator of Forests in Burma, reported his arrival in Rangoon on the 1st January, 1891, before noon.

Mr. Forteath is posted to the Upper Burma Circle.

No. 4.—*The 6th January, 1891.*—*Mr. A. M. Burn-Murdoch*, Assistant Conservator of Forests, is posted to the Pyinmana Division.

No. 5.—*Mr. H. H. Forteath*, Assistant Conservator of Forests, is posted to the Chindwin Division.

No. 6.—*The 7th January, 1891.*—Under the provisions of Section 35, clause (2) (*b*), of the Forest Department Code, *Mr. W. A. Hearsey*, is appointed to be a Sub-Assistant Conservator of Forests, 2nd grade, on probation, and is posted to the Upper Burma Circle.

No. 1.—*The 12th January, 1891.*—With reference to Revenue Department Notification No. 4 (Forests), dated the 6th January, 1891, *Mr. A. M. Burn-Murdoch*, Assistant Conservator of Forests, reported his arrival in Pyinmana on the forenoon of the 8th January, 1891.

No. 21.—*The 22nd January, 1891.*—The following alterations of rank are ordered, with effect from the 24th November, 1890, consequent on the return from privilege leave of *Mr. J. Nisbet*, Deputy Conservator of Forests, 2nd (officiating 1st) grade :—

Mr. E. S. Carr, Deputy Conservator, 3rd (officiating 2nd) grade, to revert to his substantive rank.

Mr. C. H. Hobart-Hampden, Deputy Conservator, 4th (officiating 3rd) grade, to his substantive rank.

No. 2.—*The 23rd January, 1891.*—With reference to Revenue Department Notification No. 6 (Forests), *Mr. William Andrew Hearsey*, reported his arrival in Mandalay on the afternoon of the 24th December, 1890.

No. 1.—*The 26th January, 1891.*—With reference to Revenue Department Notification No. 1F., dated the 2nd instant, *Mr. J.*

Messer, Assistant Conservator of Forests, joined the head-quarters of the Working Plans Division at Prome on the forenoon of the 7th idem.

9.—ASSAM GAZETTE—

No. 10787.—*The 26th December, 1890.—Mr. W. F. Lloyd*, Assistant Conservator of Forests, received charge of the Nowgong Forest Division from *Major M. A. Gray*, Deputy Commissioner of Nowgong, on the forenoon of the 1st December, 1890.

No. 1093.—*The 5th February, 1891.—Mr. W. F. Lloyd*, Assistant Conservator of Forests, 3rd grade, is promoted to the 2nd grade of Assistant Conservators of Forests, with effect from the 17th November, 1890.

10.—MYSORE GAZETTE—

No. 346.—*The 5th January, 1891.—Mr. E. P. Lovery*, Officiating Superintendent of Forests, Shimoga, was granted casual leave for 7 days from the 15th to the 21st September, 1890, under the terms of Rule 1 of the Revised Rules published in Proceedings No. 7140-71—Cir. 200, dated 5th February, 1881.

No. 384.—*The 3rd February, 1891.—Mr. Muddappa*, Sub-Assistant Conservator of Forests, Hassan District, is granted casual leave of absence for 7 days under the terms of Proceedings No. 7140-71—Cir. 200, dated 5th February, 1889, with effect from such date as he may avail himself of the same.

No. 399.—*The 11th February, 1891.—Mr. E. P. Lovery*, Officiating Superintendent of Forests, Shimoga District, having availed himself of the three months' privilege leave granted him in Notification No. 435 of the 12th October, 1890, from the 4th idem, and returned to duty on the forenoon of the 18th December, 1890, the unexpired portion thereof, *viz.*, 17 days, is cancelled.

11.—BERAR GAZETTE—

Nil.